ARTICLE V.—The Library shall be divided into TWO CLASSES; the first comprising such work as, from their rarity of value, should not be lent out, all unbound periodicals, and such text books as ought to be found in a library of reference except when required by Committees of the Institute, or by members or holders of second class stock, who have obtained the sanction of the Committee. The second class shall include those books intended for circulation.

ARTICLE VI.—The Secretary shall have authority to loan to members and to holders of second class stock, any work belonging to the SECOND CLASS, subject to the following regulations.

Section 1.—No individual shall be permitted to have more than *two books* out at one time, without a written permission, signed by at least two members of the Library Committee, nor shall a book be kept out more than TWO WEEKS; but if no one has applied for it, the former borrower may renew the loan. Should any person have applied for it the latter shall have the preference.

Section 2.—A FINE OF TEN CENTS PER WEEK shall be exacted for the detention of a book beyond the limited time; and if a book be not returned within three months it shall be deemed lost, and the borrower shall, in addition to his fines, forfeit its value.

Section 3.—Should any book be returned injured, the borrower shall pay for the injury, or replace the book, as the Library Committee may direct; and if one or more books, belonging to a set or sets, be lost, the borrower shall replace them or make full restitution.

ARTICLE VII.—Any person removing from the hall, without permission from the proper authorities, any book, newspaper or other property in charge of the Library Committee, shall be reported to the Committee, who may inflict any fine not exceeding twenty-five dollars.

ARTICLE VIII.—No member or holder of second class stock, whose annual contribution for the current year shall be unpaid or who is in arrears for fines, shall be entitled to the privileges of the Library or Reading Room.

ARTICLE IX.—If any member or holder of second class stock, shall refuse or neglect to comply with the foregoing rules, it shall be the duty of the Secretary to report him to the Committee on the Library.

ARTICLE X.—Any member or holder of second class stock, detected in mutilating the newspapers, pamphlets or books belonging to the Institute shall be deprived of his right of membership, and the name of the offender shall be made public.

THE

PRACTICAL FLAX SPINNER:

BEING A DESCRIPTION OF THE

GROWTH, MANIPULATION, AND SPINNING OF FLAX AND TOW.

A FLAX AND TOW SPINNING MILL, IRELAND.

THE

PRACTICAL FLAX SPINNER:

BEING A DESCRIPTION OF THE

GROWTH, MANIPULATION, AND SPINNING

OF FLAX AND TOW.

BY

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BELFAST.

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PREFACE.

THIS work is a reprint—with considerable additions—of a series of Articles* which have appeared monthly in the *Textile Manufacturer* for a period of about four years. When the Author commenced these Articles there was no work treating the subject of Flax and Tow Spinning *in extenso*.

The want of a trustworthy book of reference had long been felt by those engaged in every department of the trade. The writer has endeavoured to meet this want, and he trusts that this work will be found useful to all who wish to gain a thorough knowledge of Flax and Tow Spinning. He has spared no pains to make the information given of the various parts of the manufacture both complete and trustworthy.

* The first Article appeared in July, 1880; the last in May, 1884.

INTRODUCTION.

In the present time of severe competition it behoves us to reduce, as nearly as possible, to mathematical exactness, every detail connected with our recently-developed and most important industry—Flax and Tow Spinning.

Before the general introduction of steam as a motor this manufacture was conducted in a very primitive style in many, if not most, of the rural homesteads of Ireland.

Since that epoch, flax spinning has gravitated to centres pre-eminently favourable for the carrying-on of the pursuit. Durable, and not infrequently, elegant buildings of stone or brick, sometimes of very extensive proportions, have been erected in these places, and filled with machinery of ingenious and delicate construction.

These "Spinning Mills," though of such recent origin, are now to be found in most countries of Europe, if not even farther a-field. At present there are about three and a half million spindles, absorbing about twenty-five million pounds sterling of capital, and giving the means of subsistence to more than a quarter of a million souls, evidencing the importance of this branch of the linen trade. Of this a large proportion is still in the hands of capitalists in Belfast, Ireland, a city which has always enjoyed the reputation of being the chief centre of flax spinning, and which, in fact, may be said to have had a monopoly of it until some twenty-five years ago.

Since that period so great an impetus has been given to flax spinning in consequence of the scarcity of cotton, caused mainly by the American civil war, that mills could scarcely be erected fast enough to absorb the flow of capital into this channel. Thus the manufacture, which had previously been chiefly confined to the province of Ulster, extended itself beyond the bounds of the United Kingdom; and the number of spindles employed increased from about three-quarters of a million to three and a quarter millions.

The distribution of the industry over various countries is shown in the following return of the "Belfast Flax Supply Association" for 1882:—

Country.	Spindles.
Ireland	873,242
England and Wales	190,808
Scotland	265,263
France	500,000
Austria and Hungary	488,020
Belgium	306,040
Italy	59,223
Germany	318,467
Russia	160,000
Holland	7,700
Sweden	3,810
Switzerland	9,000
Norway	1,800
Total spindles	3,183,373

For extract from *Belfast News Letter*, please refer to Note 1, Appendix.

The result of such a rapid and undue development of the manufacture is such as might have been anticipated. Much capital has been lost. Trade still languishes, and improvement cannot be expected until the demand equals the supply.

Not only have many of the principal markets of the world been closed against us, from their becoming self-supplying, but, besides, we have now to contend against severe competition in our own markets from some of these quarters.

As illustrative of the development of flax and tow spinning on the Continent, let us take the case of France, extracting our information from tables compiled principally from returns by the "Comité Linière de Lille."

First, they give us a table of the value of the imports and exports of linen yarn over a lengthened period :—

Year.	Imports.		Exports.	
1861	5,300,000	francs	1,500,000	francs
1862	5,600,000	,,	3,100,000	,,
1863	7,700,000	,,	26,600,000	,,
1864	5,100,000	,,	21,500,000	,,
1865	9,900,000	,,	11,900,000	,,
1866	9,300,000	,,	8,600,000	,,
1867	9,800,000	,,	6,200,000	,,
1868	14,100,000	,,	5,300,000	,,
1869	10,200,000	,,	5,800,000	,,
1870	10,300,000	,,	3,400,000	,,
1871	11,300,000	,,	8,500,000	,,
1872	8,600,000	,,	12,900,000	,,
1873	5,700,000	,,	15,600,000	,,
1874	5,400,000	,,	18,700,000	,,

Second, we have a table of the tariff which they levy on imported Linen Yarns. This is for the finer counts of yarn only, the tariff on the coarser being, to all intents and purposes, prohibitory :—

Lea of Yarn.	Duty in Francs Per 360,000 Yards. (Six Bundles.)	Actual Value Per 360,000 Yards. (Six Bundles.)	Approximate Duty. Per Cent.
80's	4·08 francs.	38·12 francs.	11 per cent.
90's	3·60 ,,	37·50 ,,	9 ,,
100's	3·25 ,,	38·12 ,,	9 ,,
110's	2·95 ,,	38·12 ,,	8 ,,
120's	4·50 ,,	33·75 ,,	13 ,,
130's	4·18 ,,	40·00 ,,	10 ,,
140's	3·90 ,,	43·75 ,,	9 ,,
150's	3·62 ,,	47·50 ,,	8 ,,
160's	3·40 ,,	52·50 ,,	6 ,,
170's	3·20 ,,	52·50 ,,	6 ,,
180's	3·02 ,,	52·57 ,,	6 ,,

Third, the great advantage the French have over us in the matter of hours of work and of wages is shown by the following table, the time of comparison being the year 1875 :—

	(France, per week of 72 hours.)	(Ireland, per week of 56½ hours.)	(In favour of France.)
Roughers	14/6	20/-	43 per Cent.
Sorters	21/6	25/-	32 ,,
Preparers	8/6 @ 11/-	7/6	— ,,
Spinners	8/6 @ 12/-	8/6	5 ,,
Reelers	10/-	8/6	8 ,,
Mechanics	21/8	33/-	49 ,,
Carpenters	16/10	32/-	59 ,,

Taking a just view of the significance of the information contained in these tables, and aiming at the further cheapening of the cost of production, by making our by no means inefficient machinery still more automatic, we

may reasonably hope not only to retain our pre-eminence in flax spinning, but even to place ourselves more on a par with the elder sister "cotton spinning."

Spinning mills are different now from formerly. There are those who could tell of the parsimonious and thoroughly unpractical manner in which the business of some places was conducted; frequently in badly adapted and much dilapidated buildings which, under less favourable circumstances would have nipped in the bud any chance of success in flax spinning. For, as were the buildings so was the machinery; if the walls, ceilings, and stayings were mouldering, the machines were all but certain to present a corroded and rickety appearance, such as could not be attributed to age only. The very employés, who had spent much of their life in such establishments, insensibly acquired the impress of antiquity so plainly stamped on their surroundings.

Now many of our Joint Stock Companies and private establishments display the true spirit of enterprise in providing the most commodious, well-ventilated, and well-lit buildings, kept in the most scrupulous order; and in procuring plant and machinery of the newest and most approved make, properly adapted, and kept in thorough repair, mainly by not being "too much forced." An establishment of this stamp, manned by skilled contented artisans, and directed by untrammelled management, will weather storms such as the worn-out, ill-provided hulk could not contend against.

In illustration of the manner in which the Joint Stock Companies conduct the financial part of their business, we append a balance sheet (p. x.) of a flax and tow spinning mill of average size (15,000 spindles) in fair working order, and of good repute. Average lea of yarn, 100's weft; average yearly wages, £16,000; and average number employed, 600.

This statement shows the proportion of spindles to operatives to be as twenty-five to one, and the yearly wages in pounds sterling to be little more than the total spindles.

Although this is a fair average yet it cannot be taken as adequate for the proper working of every well-regulated establishment. For, when the class of work is coarse, the proportion of spindles to operatives employed, decreases, and the wages proportionately increase. When finer counts of yarn are being spun, the reverse of this takes place.

Thus the proportion of spindles per person employed may range from twenty to thirty, and of wages per spindle from twenty-four to eighteen shillings per annum.

The extent of a spinning mill is regulated not only by the number of spindles it contains, but also, to some extent, by the class of work to be produced. The coarse material requires more cumbrous machinery, so much more cumbrous that 20,000 coarse spindles may occupy as much space as 30,000 fine. The power required for propulsion increases in proportion to the coarseness and quantity of the article produced, but it is also greatly dependent upon the proportionateness, concentricity, and condition of the plant and machinery.

No mill should consist of less than 8,000 or 10,000 spindles; some exceed 40,000. A mill of 8,000 spindles, or thereabouts, can be carried on as economically as a much smaller establishment, the latter having as many "departments" as the former, and, consequently, being in quite as much need of skilled oversight. Indeed successful management mainly consists in securing the services of the most efficient overlookers for the various departments.

But this efficiency commands a price practically inadmissible where the charge is of too limited an extent. Consequently the small charge has to dispense with skilled oversight, unless in exceptional cases, or where there is skill minus some such indispensable quality as energy, honesty or obedience.

Dr. CAPITAL AND LIABILITIES.	£	s.	d.	ASSETS. Cr.	£	s.	d.
£15 per Share, on 2,000 Shares (£50)	30,000	0	0	Mill Property, Machinery, Houses, etc.	51,000	0	0
Reserve Fund	22,050	0	0	Purchase of Profit Rent	2,915	4	7
Banker's and Temporary Loans	20,645	14	10	Stocks, Flax, Tow, Yarns, and Sundries	19,966	15	2
Bills Payable	15,669	15	3	Sundry Debtors	22,558	9	6
Sundry Creditors	1,619	4	1	Cash on hands	23	14	0
Wages Unpaid	500	0	0				
Building and Machinery Renewal Acct. (Balance as below)	819	6	10				
Profit and Loss (Balance as below)	5,160	2	3				
	£96,464	3	3		£96,464	3	3

PROFIT AND LOSS ACCOUNT,

	£	s.	d.		£	s.	d.
To Balance from last Account	4,013	0	6	By Spinning, Profit on this Account	11,085	14	9
,, Ordinary Directors' Remuneration for 1878-9	150	0	0				
,, Dividend at 5 per cent., paid 4th November, 1879	750	0	0				
,, Auditor's Remuneration for past year	12	12	0				
,, Building and Machinery Renewal Account	1,000	0	0				
,, Balance carried down	5,160	2	3		£11,085	14	9
	£11,085	14	9	By Balance brought down	£5,160	2	3

BUILDING AND MACHINERY RENEWAL ACCOUNT.

	£	s.	d.		£	s.	d.
To new Machinery purchased	1,085	18	0	By Balance from last Account	905	4	10
,, Balance to new Account	819	6	10	,, Profit and Loss	1,000	0	0
	£1,905	4	10		£1,905	4	10

RESERVE FUND.

	£	s.	d.		£	s.	d.
To Balance to new Account	22,050	0	0	By Balance from last Account	21,000	0	0
				,, Interest for past year	1,050	0	0
	£22,050	0	0		£22,050	0	0

Some small proprietors try to negative this difficulty by amalgamating some of the "charges," to be under their own supervision, or they place them under that of some reliable substitute. They thus hope to economise in the management of their establishments. But we believe we are correct in saying that this arrangement has seldom met with substantial success. This we say without any disparagement of the unwearying energy and great intelligence generally exhibited in such cases. The commander-in-chief would be as likely to lead his soldiers to victory without his officers, or the landed proprietor to conduct the affairs of his estates without stewards, as the intelligent man, single-handed, to undertake successfully the oversight of all the details in connection with his spinning mill. Man is neither omniscient nor ubiquitous.

On the other hand, objections can be advanced against the founding of those mammoth spinning mills which owe their origin chiefly to the speculative enterprise of Joint Stock Companies. In these establishments (which are happily the exception and not the rule) the various departments, likewise of abnormal extent, have to be sub-divided into "rooms" or sections, each of these being placed under the charge of an overlooker, and these overlookers being held responsible to one who is "head" over the particular department. These "head" men receive their orders from the sub-manager, and he from the general manager. The general manager has to consult and be guided by the managing director, and the latter has to work in conjunction with the head director. In such an establishment the broth is, no doubt, often spoiled, but even this is preferable to its entire disappearance from the inadequate utensil.

Thus is the acquiring of a spinning mill of fair proportions, say of from 10,000 to 25,000 spindles, only second in importance to the securing of the best possible intelligence for its proper conducting.

Having glanced at the growth, extension, and present condition of our flax spinning trade, and having briefly referred to the main ends to be kept in view by those desirous of assuring to themselves success in this enterprise, we proceed to place before our reader, in the following pages, the "minutiæ" of the business in a manner which, we trust, shall be found not only instructive but interesting.

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PART I.

FLAX DEPARTMENT.

THE

PRACTICAL FLAX SPINNER.

CHAPTER I.

FLAX.

THE manufacture of flax has latterly become so important that it is not an unsuccessful rival of cotton manufacture—the staple trade of Great Britain.

Structure of Flax.

The flax plant *(linum usitatissimum)*, upon the wide and successful growth of which this great industry depends, is of very singular construction. Each stalk is composed of a pulpy or woody tubular or cylindrical substance, called, variously, the "haum," "boon," or "harle," around which clings a network of longitudinal rectilineal filaments, exquisitely connected or banded together by ligaments. (See Note (2) Ap.)

Divisibility of Flax.

On the complete separation of the bast tissue from the woody matter; the skilful severing of the multitudinous ligaments; and their removal from the fibre with the least breaking up or "slaving" of the latter; depends, to a great extent, the successful manufacture of flax. The fibres of sound not overgrown flax admit of being separated from each other to an indefinite extent, and, when they have become so fine that they seem to be reduced to single fibres, the microscope reveals the fact that these apparently single fibres are in reality still composed of many, which only require to be operated on by finer instruments to be divided, and again divided, *ad infinitum*.

Judging Flax.

The proper judging of flax consists in selecting that which will stand most of this separating or "cutting" of the fibre with the minimum loss. Flax that cannot bear this splitting partakes too much of the nature of a grass, and will turn out badly, both as regards work and wear. It may be regarded as an established fact that the more completely the separation of the fibre is effected in the first or "hackling" process, the more easy, economical, and successful will be its manipulation in succeeding stages. The superior development of this all-important quality of divisibility in flax depends upon many things combined, as quality of seed and soil, suitability of weather and water, and the mode of treatment generally. It is our intention to lay before the reader, as clearly and concisely as may be, some general remarks on the treatment of flax in its various stages.

Growth of Flax.

The flax plant can be grown in any temperate climate, but it flourishes best where exempt from extreme frosts or heavy rains. The most suitable soil for its growth is that of a deep loamy, or slightly sandy, nature; of level surface, and with no obstruction, as trees, &c., to the sun's rays.

For flax seed Ireland depends principally upon Russia and Holland, as in these countries the husbandmen consider that the price they receive for the seed fully compensates them for any deterioration that may accrue to the quality of the fibre, from overgrowth, necessary to the saving of the seed.

Flax Seed.

Commission merchants and agents import foreign seed in cargoes at a time, the season for so doing being from the month of November to May, inclusive. The price of flax seed depends upon various circumstances, not the least important of which is the navigability of the Baltic. Good seed is plump, smooth, and glossy; but the surest criterion of excellence is the name of the shipper, as certain houses have earned a good name, and do not care to jeopardise it by putting an inferior article into the market. Some of the best known shippers and brands are:—For Riga—Jacobs, Mitchell, Rucker, Renny, etc.; for Dutch—M. B. M., D. and V., Æ. T. B., S. P. J. T., H. and D., etc.; and if the farmer be sure that he is really receiving seed of these brands, he need not fear to pay a good price for it, as so doing will repay him a hundred-fold. But he need not hope to secure sound seed unless he procures it direct from respectable commission houses as there is scarcely any trade in which more dishonesty can be practised than in this. The writer has known 10s. each to be offered for empty seed barrels bearing the best brands, that they might be refilled with inferior seed and vended through the country at markets and fairs as the genuine article. He is sure these tempting offers are accepted in many cases, even by merchants who hold their heads high, but in the particular case referred to, the gentleman was proof against the inducement offered, even five times told. (See Note (3) Ap.)

Buying Seed.

It does not require a far-seeing mind to comprehend the ruin resulting from inferior seed being spread over the country; the deceived farmer for ever abjuring flax in any form; the markets stocked with flax of inferior quality and quantity, driving the buyers to other and more fortunate localities, which on their advent run up their prices; this, in the long run making itself felt by the population, in the shape of dearer goods. But let us hope that the farmer has displayed ordinary discretion, and deemed it better to procure seed of the best brand from a respectable house, even at a little extra cost, and that previous success in flax growing has not made him so greedy that he tries to grow flax on soil impoverished by successive heavy crops. Showing moderation and discrimination in this as well as in the matter of procuring seed, he can scarcely fail to reap a large profit from flax cultivation, that is if the weather be propitious; and last, but not least, if he has read the valuable rules and remarks compiled for flax growers by Mr. Andrews, secretary of the Belfast Flax Supply Association.

Rules for Flax Culture.

When it is considered that the price of the raw material constitutes from one to two-thirds of the entire cost of producing yarn, it will be seen that, comparatively speaking, no advantage is taken of the almost unlimited resources of nature in the shape of fibre-producing plants. These sources of wealth only require to be utilised to produce a revolution in textile manufactures.

Fibrous Plants.

As an illustration of the many sources from which fibre may be had for textile manufacture, the author extracts from "Tropical Fibres," by E. G. Squier, the names of a few orders of the fibre-producing plant:—Agave, or amaryllis family; Bromelia, or pineapple family; Nuesa, or plaintain family; Yucca, or lily family; palm family; Pandanceæ, or screw-pine family; Urtica, or nettle family; Malva, or mallow family; Lilia, or lime-tree family; Leguminosa and Asclepia, or milkwood family. It is scarcely necessary to remark that varieties of many, if not of all, of these orders would be utterly unfit for

textile purposes; but, again, there are many varieties that produce the very finest fibre, and if a little practical experience, combined with scientific knowledge, were brought to bear upon the mode of cultivation and manipulation of the various plants, most, if not all, fibres could be treated so as to be commercially profitable.

Diseases of Flax Plant.

The causes of certain diseases of the flax plant have been examined and described by M. Alfred Renouard, fils. The following extracts on the subject have been taken from the TEXTILE MANUFACTURER :—

"The flax plant is subject to many diseases, some of which are of great importance to the manufacturer, while others are less so, though they all affect the farmer, as influencing the quality or the quantity of the fibre to be obtained, or both.

"What is called fire blackens the plant in its upper and makes it yellow in its lower parts. This is caused by long, strong manure, containing too much ammonia, and the too frequent planting in the same soil that has been manured in this way.

"Reddening of the extremities of the plant is caused by too much drought, and this affects the fibre so much that the parts which have been attacked are difficult to set.

"Rust is manifested by brownish patches. It has nothing in common with what is called rust in other plants, and which generally is produced by an insect or a fungus. M. Renouard's careful observations have led him to the conclusion that this malady is noticed mostly in the neighbourhood of the sea, and is caused by fogs, which leave drops of water on the plant. These drops are then evaporated by the rays of the sun, and thus leave after them the black or red spots which are so damaging to the quality of the fibre. Sudden heat kills the plant in parts for want of moisture before it has arrived at maturity. The portions affected get yellow, and there is consequently a reduced production of useful fibre.

"Continued heavy rains often destroy the tips of the branches, and cause new ones to spring up near the ground, or in the middle. The fibre, in this case, takes a bad colour, and is much depreciated in value. Only timely occurrence of fine and warm weather can save it from complete destruction. In some cases the plant thrives too rapidly, and the flowers disappear long before the plant is ripe and the fibre consequently matured. This occurs when the farmers put too much manure on the ground, and thus cause too great a heat and the presence of insects.

"Fungi are perhaps the most fatal pests to which the flax plant is subject. We need not inquire into their origin, or the cause of their attacking this plant, about which there seems to be a diversity of opinion, but will merely state that the disease consists in the growth of numerous small fungi on part or the whole of the stem, which, after a few days, lay the fibre bare, and then attack this also. Where this malady is discovered in time, and the plant has already sufficiently advanced, there may be a small percentage of usable fibre left, which, however, must be looked upon with suspicion by the spinner. If the fungi are thoroughly developed, the best thing the farmer can do is to pull the plant up and destroy it, for where they are introduced into a storeroom they may do incalculable damage. It is rather remarkable that these fungi are found only on blue flax, and never on the coarser kind, which has white flowers, nor on flax which has been grown from seed freshly imported from Riga."

Sowing Flax.

The average quantity of seed used per English acre is two and a half bushels, but great discrimination is here necessary, as so much depends upon the quality of the seed and the adaptability of the soil. However, it is safer to put too much than too little seed in the ground, as when it is thickly sown the fibre is usually

straighter and of finer quality than when the sowing is too thin. When the fibre has obtained a sufficient growth, which may be judged by the "capsule" or seed ball being firm and of a dark green inside —instead of being soft and whitish, as when unripe—it is pulled up by the roots by hand, and tied in sheaves or bundles of about 20lb. each, great care being taken to keep the root ends together and perfectly even. If the plant be pulled when the ball is green the fibre may be finer, but the seed is lost. If left standing until the seed begins to drop, the result is even worse, as the juices have by this time commenced to dry up, depriving the fibre of its natural silkiness and elasticity. The bundles are carted to flax holes, full of water taken from the nearest pure stream— that is, free from mineral salts in solution. If pure soft water cannot be procured, spring water, with the hardness taken out of it by exposure to the weather for a lengthened period, is necessary. If the seed has been sown about the end of April, the flax will be ready for the water about the middle of August. The hole is filled with flax, the bundles being put in on their root end and leaning one against the other, slightly off the perpendicular. This layer is then covered with rushes or straw, so as to exclude the light, and stones are placed on the top so as to keep the whole under water. The flax should be left steeping from nine to sixteen days, according to the quality of the water and the heat of the weather.

Pulling Flax.

Watering Flax.

It may be said, without exaggeration, that the success or failure of the crop depends mainly upon the farmer knowing when his flax is sufficiently retted. If it get too little of the water, the flax will be harsh and brittle, and cannot be properly cleaned in scutching. If it be over-retted, it will be soft, and give poor yield in scutching.

Retting Flax.

When the flax is ready to be taken out of the water, which is when the fibre peels off from the "boon" with freedom, the stones which kept the flax submerged are thrown aside and the top covering carefully separated from the bundles. The hole is then usually run dry and the flax taken out, but this is objectionable. The proper way is for the men to go into the water and lift out the bundles one by one, rinsing them before so doing. This method permits the scum and dirt to be washed off, whereas, when the water is first run off, a deposit is left on and about the bundle which is injurious to the fibre.

Grassing the Flax.

On its removal from the dam the flax is carted to a level and close-cropped field, loosed out and spread upon the grass in very thin straight rows. If spread thin and evenly it will do without turning, and may be left to get the "grass" for say from one to two weeks. Here again the farmer's practical knowledge stands him in good stead, for if he lets the "straw," as it is now called, get too much of the grass, it becomes wefty and weak; and if too little, it cannot be cleaned in the scutching, which greatly deteriorates it, and lessens its marketable value. If the flax has got "too much of the water" it should get "less of the grass," and *vice versâ*, to counterbalance the evil. After the grassing it should be very carefully tied up again—level in the root end—left to winnow in stooks in the field for a few days, and then be taken to the stackyard. It will very much improve the quality of the flax if the "straw" be left in stack some time before being sent to the scutch mill.

Stacking the Flax Straw.

The scutching is commenced by the "straw" being passed through crushing "rollers," which are heavy iron cylinders, about 3ft. broad by 1ft. diameter, fluted with $1\frac{1}{2}$in. diameter flutes, which break the "boon" and partly separate it from the fibre without detriment to the latter. After the "straw" has been well softened by frequently passing through these rollers, or through others

Bruising the Straw.

of finer flute, the "scutcher" receives it, and, taking up as much straw as he can firmly hold in his right hand, he lets the root end of the "finger," as it is now called, drop in between the "stock" and the "buffer." This "buffer," when revolving, appears to be a narrow wheel, but it is in reality simply a boss fixed upon a quickly-revolving horizontal shaft, driven by water or steam-power. In this boss are inserted six or eight beaters or "handles," rising about 18 inches from the boss all round. These are usually made of good tough beech, which will keep a fair edge. These revolving handles strike the flax straw downwards with great force, as it is brought close to them by having to pass between a stout iron frame and the beaters.

Buffing the Straw.

By feeding-in the straw gradually, and turning and opening it out to the action of the beaters, the scutcher soon has most of the "boon" struck off the fibre, when he turns the "finger" and puts the top end through the same process, thus concluding the "buffing."—(See Note (4) Ap.)

Mill Scutching the Flax.

Careful scutchers do not finish the scutching of the flax immediately after buffing, but let it lie in piles in this state for some days, so that the fibre may "come to," as they say. After having "come to" it undergoes the finishing process, this being merely a repetition of the buffing, except that the "stock" is set closer to the handles. The scutcher goes over the "finger" of flax on the close set handles, cleaning it out thoroughly. After passing another "finger" through the same process, he places the two together, gives them a final rub, and thus he has a large handful of well-cleaned flax, which in this form is called a "strick." The scutched flax is tied up in bundles of 14lbs. weight, called a "stone of flax," and in this form is ready for market. There are from five to eight "stricks" in the "stone," according to the manner in which the "straw" has yielded.

A Stone of Flax.

Yield of Flax per Acre.

About two tons of "straw," yielding four hundredweight of flax fibre, is considered fair yield to the English acre; but the writer has known the enormous yield of eighty-five "stone" from three bushels of seed.

Scutchers' Stratagems.

The farmer requires to be on his guard against various little deceptions the scutchers practise occasionally, viz., making each stone of flax a few ounces light; allowing a large portion of scutching tow and impurities to remain in the ends of the flax, etc. The tendency to these practices is due to the fact that the scutchers are paid by the piece—say from 9d. to 1s. 6d. per "stone."

It may not be uninteresting here to give an extract from "A Document published by the Belgian Government in 1841, on Flax Cultivation." It is the more worthy of attention from the fact that to this day Ireland cannot compete with our Continental neighbours in either quality or price of flax, although possessing every natural advantage for its successful growth:—"The flax of Ireland when first pulled is as good as ours, but the Irish are negligent. Our flax is immediately put in water; theirs is left to get heated in the air while they go away to drink and enjoy themselves. Our peasants are watchful, and take out the flax at the end of five or eight days, according to the condition in which they find it; the Irish do it just when they please. Our flax when covered with mud is spread out carefully in a fine meadow, when the first shower cleanses it; in Ireland it is thrown down almost anywhere. The women, with us, often take the preparation of the flax upon themselves, but in Ireland the flax is prepared in mills. We have sent some families to England, who have since returned, and they inform us that very good flax could be reared in that country. During the war, when neither we nor Holland exported flax, the English contrived to produce equally good linen with that which they manufacture at the

present time. They then cultivated good flax in Yorkshire and in Ireland, but since that time they have neglected its culture."

The "hand-scutching" referred to in the foregoing extract is now only practised on the most valuable lots of fibre, and in Ireland in those out-of-the-way places where there is no "scutch mill," and where labour is cheap and plentiful, as the process is tedious and does not soften and give the same finish to flax of ordinary quality as when it is "mill scutched." Flax of the purest and most "warpy" nature will retain these qualities in a pre-eminent degree by being hand-scutched. The artificial drying of the "straw" by fire or kiln is very injurious to the fibre, leaving it hard and "haskey."

Hand Scutching.

Artificial Drying of Flax.

CHAPTER II.

FLAX BUYING.

THE buying of flax from the farmer, scutcher, or dealer, for the spinner or commission merchant is a matter of importance. It is also difficult, on account of its sale being so much in the hands of dealers, or "jobbers," men who make their living by frequenting the various towns on market days.

Flax Buying. A favourite way of procuring flax for the spinning mill is for the "buyer" to go round the various scutch mills accessible by car, from day to day, examining lots of flax entirely or partially scutched, and buying those that may suit him, on the best terms he can make with the foreman scutcher. Flax obtained in this way usually "turns in" well. But in some cases there might be danger of the foreman selling by picked samples, or changing lots after receiving the buyer's ticket. Sometimes it happens that the farmers are not satisfied with the prices procured for their flax in the scutch mill, and re-sell it in the public market, instead of delivering it at the buyer's store, as agreed upon. This does not frequently occur, however, as respectable scutch mills will not countenance such double dealing.

In the public market the buyer has to keep his eyes open, indeed, to be a match for the dozens of dealers trying to turn a "thrum." In order to effect his object the dealer stops and listens to the bargaining going on between the buyer and the farmer over a load of flax, and in time edges in a word by kindly advising the farmer to accept the buyer's offer, "if he is wise." The effect of the dealer's interference is not unfrequently to prevent the completion of the purchase, as the farmer becomes suspicious of the dealer's advice, and is less disposed to close. But if the flax be purchased, the dealer, for his "disinterested aid," expects the buyer to allow him the customary "thrum," which is 3d. per stone on every stone the load contains. Again, if a flax buyer desires to make a larger market of flax than he himself can select in the short time during which the market lasts, he may commission a dealer to buy a load or two for him, if any be found to suit. Besides the modes of earning a livelihood which have been mentioned, the dealers generally have private stores in the market towns they attend, in which they store lots of flax they may have picked up cheap at the "tail" of previous markets, and any odd lots purchased in the country during the week. These are all opened by expert hands, and whipped, handled, wrung, pressed, and mixed so as to have the appearance of being 1s. or 2s. per stone better value than the flax really is. Mixing the flax is a process by which the unwary are most likely to be deceived, as it is not only in dealers' stores, or "under the slates" (that being the term applied to flax bought in this manner, in contradistinction to the more legitimate method of buying it "off the street" in open market) that these doctored or "jobbed" lots are met with. In some instances old, or last season's flax, which is never worth within 1s. a stone of new, is carefully mixed with new flax, handled and tied up to represent the "tying" of some particular scutch mill (each mill having a method of "getting up" peculiar to itself, and easily distinguishable by any "old hand"), and then piled side by side with some very fresh-smelling lot of

Margin notes: A "Thrum." — "Jobbed" Flax.

flax, or even placed in the heart of it, the object of this being to kill the musty smell acquired by age, and so cause old flax to pass for new. It is then ready for putting into a cart (a very dirty and travel-stained one) and brought into the market, to be sold as fresh from the scutch mill, or it is exposed for sale in the dealer's store. Here it is sold to some buyer who has been incapacitated, by the previous night's debauch, from rising in time for the commencement of the market. Such a one finds it more to his ease and interest to pay the "thrum" on the dealer's store full of flax; this honest, hard-earned 3d. per stone being, of course, all that the dealer is supposed to make off his sales, as he is perfectly ready to produce the duplicate tickets of those handed to the foreman scutcher, and, besides, to give the pedigree of each lot. The following may be taken as a fair specimen of the style of conversation passing between our straightforward dealer and our friend of the "sore head":—

Under the Slates.

Dealer: "There, sir, I think this little lot is just up to your mark. I know you are not easily pleased, but just look at that (handing him a picked stick); just run your hand over that. There's only 75 stone of it, and when I came across it last Monday morning, at Smith's mill, I set myself on having it for you, although Joe (the foreman) was 'out of sorts,' and not in a good way of working. He would not hear of less than eleven 'bob' for it, but after a wee bit of 'palavering' (here a knowing wink and a playful nudge of the elbow to our 'cute' buyer) I took it off him at ten and a 'tanner,' on condition that I would let the eight stone of 'thatch' go in with the lot. Isn't it 'up to the knocker?'"

Flax Buyer: "Well, Barney, it's a brave, level-looking lot, a shade "rippy," though, and just rather much 'slaved' for my taste. Ten-and-nine is a long figure to give for it, and eight of it 'thatch,' too; so if you want me to take it you must cut a little finer in the next lot."

They pass on.

Now, Barney having "fathered" this lot very well, let us trace out its true descent. Mr. Jones, farmer, at the commencement of last season brought into market thirty stones of prime strong flax, for which he asked 13s. After it was pretty well "vitted" (Mr. Jones being well known for growing good flax, but driving a hard bargain) he got three bids for it, the highest being 12s., its full value. He was furious at this. "No," he exclaimed, "I will not take 12s. 11½d. of any man's money for it."

"Spoiling" Him.

When the buyers saw the confident mood he was in, they determined to teach him a lesson, this being effected by, as they style it, "spoiling him." The lesson is given in this wise. A buyer "goes into" the flax very keenly, tossing it well, and at last, seeing something in it nobody else could discover, offers 12s. 9d. for it. Of course the offer is not accepted, Mr. Jones now being sure that very few are as good judges as himself, and that soon some buyer will display judgment enough to take over the lot at his (Jones's) own money, the 13s. The buyers then walk away. Mr. Jones stands for about two hours longer getting bids, but none of them above 12s. He has quite a compassionate feeling for bidders who display such want of judgment, and informs them that he has been bid 12s. 9d. but will not take less than 13s. The market is at length over, and Mr. Jones has to bundle up and retire. He goes home in high dudgeon, thinking what poor fools those fellows are to miss a prime lot of flax for 3d. per stone. This same game goes on for, perhaps, four or five market days, and at last Mr. Jones gets thoroughly disgusted, and swears he will store the flax rather than part with it at less than 13s. So the thirty stones take up a portion of his barn for the space of nine or ten months, when it is once again brought to light from its mouldy resting place, and carted to market.

Mr. Jones very soon comes to know that flax is down about 2s. per stone this season, and is furious when he is offered 9s. for his 13s. flax. Home it goes again, and there it lies until Barney the dealer hears of it, drops in upon Mr. Jones when he happens to be in a downcast mood, and, starting the flax topic, gives it as his opinion that prices have not nearly touched their lowest yet, and offers to take that old musty lot off Mr. Jones' hands at 9s. The bargain is quickly closed, Mr. Jones cursing flax and all connected with flax. Barney gets this lot home, mixes it with 40 or 50 stones of strong but poor flax of the same colour and length, very newly scutched, which he bought for 8s. per stone, and this, with the addition of eight stone of "thatch" (the covering and rope of the flax straw stooks, which is always weak and dirty) thrown in with a previous lot, at 4s. a stone, is the lot our friend the sportive buyer gets for the moderate sum of 10s. 9d. per stone; certainly a very "fat thrum" indeed to Barney; in fact, a transaction calculated to inspire him with the ardent wish that there were more flax buyers addicted to the cultivation of a taste for "Nap" and "spoil five."

Dealing.

It is not only old flax that is got up in the manner described; dealers have the knack of making the best of the flax appear on the outside, and in the centre of the strick, and the centre or pulling strick of the bundle or stone is the best of the lot; so flax in dealers' hands should never be judged by the heart-strick, or by its appearance on being pulled. The real reason of "jobbed" or "jerred" flax "turning in" so badly is its high price, and the fact that the hackling machines cannot be adapted to cut the fibre of weak and strong, and long and short flax together, so as to give the maximum "yield" consistent with an open "cut."

Private Stores.

The flax-buyer should have a store of his own in each town which he attends, so that on buying a load he may send the farmer round with it at once to his store, and thus prevent the pulling to which all flax is exposed on the public street by curious or officious persons, or perchance the re-selling of the load or loads of flax. This latter contingency might cause serious inconvenience to the person who first bought, as he may have just a certain number of stones to buy, and in this case he finds himself so much short on taking in his flax for the day. Means should be taken to put down this practice of re-selling, whether in market or at mill, by the buyer who would encourage it being excluded from the fellowship of his companions.

Taking in Flax.

The proper taking in of flax into the temporary store or baling house is a very important matter. It should be done thus: An indefinite number of small paper labels, with a number or mark written or printed on each, and so many of each sort, from say, No. 1 up to No. 30, should be left in each store. Then, on market day, the buyer should commence with No. 1, or the next number to that which was used last at previous market, and label all the stones of flax, taken from the farmer who happens to have arrived first, with that number. If the buyer performs this work himself, he can see that he receives flax as good as the sample by which he bought, and that no "bucks," that is "thatch," are palmed off on him.

If two different priced parcels of flax are bought from the same man they should be kept separate by some distinguishing mark. As the different stones are ticketed they should be thrown back to a storeman, who weighs one occasionally to see that it is up to the weight, and who piles the lots separately, so as to "bale" them, for carriage home, with as little mixing as possible.

As the flax is taken in, the purchaser should enter in his pocket-book the number or mark he has put on the flax; the seller's name; the number of stones and pounds received; the price per stone or cwt., and

lastly, the calculated cost; the latter to be checked from a "Ready Reckoner." This having been done, when the time for settlement with the farmers comes, the purchaser will not be likely to make mistakes in his cash or payments, such as can scarcely be avoided where all is noise, jostle, and confusion, which is the case when money is changing hands in the public-house.

Flax Price Calculations.

For the benefit of those who cannot devote the necessary time to the subject, we give in Note 5 appendix a series of calculations on the value of Continental flaxes. These facilitate the calculation of the cost in English currency per ton (2,240lb.); the rate of exchange being taken at 11flo. 80c. for Dutch, and for all the rest at 25f.

Constant Numbers for Flax.

Further, by making use of certain "constant numbers," the cost per ton (2,240lb.) of any of these flaxes may be speedily arrived at without referring to the tables; the value assigned to the particular quantity, being multiplied by these constant numbers. Thus for—

Courtrai	Multiply	Crowns per Sack	by	4·07
Bruges	,,	Stuivers per Stone	,,	0·98
Waeregham or Blue Courtrai	,,	ditto.	,,	1·21
Ghent, Wettern, Wellern	,,	ditto.	,,	1·23
Malines, Lokeren, St. Nicholas	,,	ditto.	,,	1·3
Dutch	,,	ditto.	,,	1·52
Walloon	,,	Sous per Botte	,,	1·4
Furnes	,,	ditto.	,,	1·42
Bergues	,,	ditto.	,,	1·36
Moy	,,	ditto.	,,	1·46
Bernay	,,	Francs per 110 Livres	,,	0·74

Flax F.O.B.

The product is the number of pounds sterling per ton. To this, or to the tabulated calculations, will have to be added from 25s. to 150s. per ton, according to circumstances, to arrive at the cost per ton F.O.B.; commission, insurance, baling, carriage, freight, etc., being included under this head.

Flax Storage at Mill.

Flax grown in different districts should not be indiscriminately mixed in the flax store at the spinning mill, but should be piled carefully, and worked off in separate lots. The reason for this is that different districts have peculiarities of their own, which give best results in the working of the flax when treated separately. For instance, Newry, Rathfriland, and Ballymoney are coarse and warpy in fibre; Cootehill, Ballybay, Dungannon, warpy; Armagh, Cookstown, Lisnaskea, prime flax; Omagh, Strabane, and parts of County Antrim, and most parts of the South and West of Ireland, light-warp or wefty. Of course this is only to be taken as a general statement, as there can be more or less of all qualities found in each market.

Much of the Continental flax, as Russian, Friesland, etc., is classed by marks or letters. These are too numerous and variable to mention with any hope of the information being of use; but they form very fair marks for guidance when used with reference to any year's crop.

Reports on Flax.

In Note 6 appendix, we give extracts from an annual report on the crop of all the most important flax growing countries, compiled by Messrs. G. Armitstead and Co., Dundee; also a more exhaustive one of the Flemish district, for the same season, by Messrs. Edward Keunen and Co., Antwerp. These are interesting from the fact of their comprehending all the districts of any consequence, engaged in flax cultivation, not only in Europe, but, for as regards this branch of agriculture it is as yet synonymous, over the world.

The general tenor of the reports also leads us to remark the manifold doubts and fears that are inseparable from the pursuit of flax growing; the all-important factor that climatic influence becomes in the bringing of it to a successful issue.

CHAPTER III.

ROUGH FLAX STORE AND ROUGHING SHOP.

WHEN flax is sent into the spinning mill from the different markets it is stored in separate piles or lots. These may contain any quantity from two to twelve tons. They are usually smallest where there are fewest hackling machines, or where the smallest dressed line stock is kept, as in this latter case too much time cannot be devoted to the bringing forward of any particular quality of flax, to the exclusion of some other sort as urgently required.

Lots of Flax.

But in large establishments, where there are plenty of hackling machines, and where the dressed line stock is of proper proportion and well selected, the lots can be easily made ten or twelve tons. Where they are large, the flax is more easily kept from mixing in the rough store; the flax books can be kept with less difficulty; and there is less chance of confusion in the flax department generally. These lots are made up in the following way :—Suppose 800 stones have been bought, say in Armagh market, from 15 farmers, each man's flax having been ticketed separately, the highest number will be 15; so that if it be desired to put another parcel of flax from Armagh market to the lot before closing it, the buyer on going to the same market the week following, must not ticket the first lot of flax he takes in—number one, but number 16; reference to his pocket-book showing number 15 to have been the highest number on the last occasion.

Selecting-out of Flax.

Subsequently, as this Armagh lot may be required for work, the storeman can select-out the different farmers' parcels of flax by the labels on the stones. This careful selecting-out of the flax in the rough store before going into the mill is an all-important item in flax spinning; because flax grown by one person, and sold at one price, is usually very even—that is of the same colour, length, and strength, being grown from the same seed, raised in one field, and watered in the same hole. This being set apart by itself in the flax store of the spinning mill, the rougher (the man who puts the flax through the roughing or first process) is able to rough it better and with greater ease than if he had bad and good, long and short, weak and strong flax, in one parcel. Being well roughed, the flax will machine better, and be better dressed and sorted.

Flax to Roughers.

The rougher who happens to get his parcel made up of the tail ends of the different selections of flax cannot get over his work so speedily nor so well; the yield is not nearly so good off the machines, and the sorter has more tow, and is distracted with the number of sorts on his table. The most accurate and simple way of putting the flax through the flax department is the following:—The roughing master should weigh off to his roughers in two hundred weight parcels, out of the piles selected by the storeman, and with every parcel should go a ticket printed in the form given on next page.

The roughing master fills up his portion of this ticket, which is the number of the lot as taken out of the invoice book, the rougher's name, and the gross pounds weighed off. When the rougher "weighs in" his parcel, the total pounds of flax from him, also his tow and breakings, should equal the total pounds weighed off from flax store.

By paying close attention to the parcels during the roughing, the master will have decided what hackling machine is best suited for the parcel, and he marks the number of the machine accordingly on the parcel ticket.

After entering the contents of this ticket in his "Rougher's Pay Book," the roughing master hands the ticket to the rougher, who sticks it into his bunch of "shorts," and leaves his parcel in the machine room. When the machine master requires a parcel for a machine, he looks up one with the number of that machine on the ticket. The boy who weighs the tow and line from the machines receives and keeps this ticket until the parcel is machined, when he fills in his portion. After it is copied into the "Machine Turn-off Book," it is stuck in one of the "tipples" in its own basket, and the parcel is then ready for the sorter.

Parcel Ticket.

No. of Lot.	Rougher's Name.											Market.
No. of Parcel.	Gross Weight.	From Rough.	Rgh's Tow.	No. 1 Tow.	No. 2 Tow.	No. 3 Tow.	No. 4 Tow.	Total Tow.	Total Waste.			Longs.
No. of Machine.	Sorter's Name.											
	Sorts.	Sorts.	Sorts.	Sorts.	Sorts.	Sorts.	Sorts.	Sorts.	Total Line.	Total Tow.	Total Waste.	Total.

ROUGH-FLAX STORE.

The process which flax undergoes in the roughing shop is as follows:—The rougher, untying a stone of flax from his parcel, takes one of the stricks and separates the fingers of which it is composed. Holding a "finger" in his left hand, with the butt, or root end, from him, he separates as much flax from the bulk as he can easily hold between his forefinger and thumb (always separating those fibres that are square to each other, in order to have the less trouble afterwards). With a quick pull or jerk of his right hand he separates what he retains between his fingers from the bulk, then gives his arm a swing, and brings down the disengaged portion on his bench, or table, which is convenient to his right hand, and forms the side of his "berth." The peculiar throw of his arm—while he holds the piece of flax near the middle—allows the ends to fly forward before his hand, so that it comes down on the table in the form of a semicircle, convex to him. He repeats this operation, which goes by the name of "piecing out," taking care to have all the pieces as nearly as possible of the same size, as this is essential to good roughing; and letting each piece fall over the other on his table, only taking care that by dropping each a little more sideways than the last, he may form a straight row of pieces ranged along a portion of his table. Then by commencing at the same end again, on the top of his first layer, and dropping them in the same manner, only that he keeps his second row about two inches further in on his table than the first; and by keeping the third row plumb with his first, and the fourth as far in as his second, he can pile a bunch of "pieced out" flax of about three feet in height, and containing from one stone in weight, up; according as he has extended the base of the pile. When he has done sufficient to keep him occupied in "roughing" an hour or so, he commences this operation by lifting the last and top piece off the pile at his side, and as he kept the root end of the flax off him, in the piecing out, so now the root end is before his hand. He takes up the piece very near the "top end," so that nearly the whole length of the flax is before his hand, which, by a jerking motion, he throws behind him, and draws suddenly back, thereby causing the flax to crack like a whip, making the tangled ends to separate and come down well spread over his "hackle," which lies firmly bolted to the wooden bench before him. He pulls the piece through the hackle, and on account of his having caught hold of the piece so near the top end, even though his hand tightly grips the flax, a great portion of it drops away, and is retained by the root end in the hackle. This is exactly the object aimed at, to thoroughly square the root end of the piece, as it is the uneven portions that are retained in the hackle. He then catches the root end of the piece between the finger and thumb of his left hand, and placing it over the corner pins of the hackle, pulls any other fibre that may come out of the piece; by drawing the flax towards him with his right hand, and retaining the ends in the hackle with his left, the weaker fibres drop down over the rest in the hackle. Then gripping the piece in his right hand a little closer to the middle, he catches up those fibres that are lying in the hackle. An experienced rougher knows exactly where to fasten his hold upon what lies in the hackle, so that when he pulls the whole together, by main force, those fibres that were retained in the hackle fall exactly square with the rest of the piece. If it happens that all portions are not exactly square, at this juncture he can square them by holding the piece close to the root end in his left hand, and, disengaging the unequal portions, replace them again in their proper position. To complete the roughing of the "root end," he, by a quick turn of his right hand, laps the top end of the flax round it, with the end that he is roughing lying well spread between his finger and thumb, then with another crack he drops the end evenly over the hackle,

Roughing.

Piecing-out.

Dropping.

Squaring the End.

draws it straight and steadily through, clearing the remainder of the short fibres out of it; and again catching the root end in the fingers of his left hand, this time laps it round what is called a "touch-pin" (a sharp square or triangular steel pin, set upright in a block of hard wood which is firmly bolted to his bench, on the left-hand side of his hackle), and, giving his right hand a jerk, breaks off all the remaining loose, short and straggling fibres, leaving a perfectly square root end.

Rougher's Lap.

The rougher next turns the piece in his right hand, and puts the top end through the same process, minus the dropping. He then lays the piece upon his bunch of roughed flax, but instead of untwisting his hand out of the flax he simply draws it away from the piece, thereby leaving a half twist, called the lap, on it, which prevents the different pieces from amalgamating. This would cause the machine boys to toss the flax greatly in taking it off the bunch to put it into the holders.

Rougher's Day's Complement.

This description of the process of roughing takes much more time than is required by the workman to perform it. There are from five to nine pieces in the pound weight of roughed flax, and a good rougher can do 300lb. weight of fair work in the day of ten and a half hours, or from five to seven 2cwt. parcels per week.

Pieces of Flax to lb.

The poorer the quality of the flax the larger the pieces may be made in the roughing, as, on account of so much tow coming off, if they were made the size of pieces out of good flax, when the parcel arrived in the sorting shop the sorter could not make anything like his fair wage, he being paid, as is the rougher, by the piece—*i.e.*, so much per hundredweight, or part thereof. Nor in this case could the sorter get as fine a sort as if he were hackling a piece of proper proportions.

Checking the Rougher.

As before remarked, next to level piecing and roughing a square root-end is indispensable. This latter point is judged by holding the piece root-end foremost, in the right hand, and with the left catching it about six or eight inches from the root. If the piece be held perpendicularly, with the root-end up, any short fibres that may be in it will bristle up about the left hand, the heavy root-end falling away from them, and by rolling the end between the fingers, and shaking the hand at the same time, the end may be sifted all through.

Breaking the Ends of Flax.

Many roughers, besides not squaring their flax properly, will shirk the breaking of the ends if not diligently supervised; and, to lessen their labour, will sharpen the "touch-pin," so as to cut instead of break the fibres, this being very injurious to the flax. As the straggling fibres are broken off the rougher drops them into the hackle, and when the short fibres and tow have accumulated so as almost to fill his hackle, he twists his fingers among the longer fibres, lifting the whole out of the pins, and,

Shorts.

working off all the tow over the pin points, he retains the short fibres. These he puts in a bunch by themselves, and weighs in with his roughed flax, called longs, to the machines. This bunch is called the shorts.

Classes of Flax to be Roughed.

Irish flax is the most difficult to rough properly, being carelessly handled and scutched, and so requiring more dropping and squaring than any other flax. Other kinds, such as Russian, German, Italian, and Irish hand-scutched, are of such poor quality as not to warrant much outlay in their dressing; or of such fine quality, as French, Belgian, Dutch, English, and also some Irish mill-scutched flax, as to have been considered worth every attention in preparation for market, which care makes the dressing so much easier.

ROUGHERS' BERTHS.

These differences are satisfactorily arranged by a sliding scale of rates per hundredweight, according to the requirements of each individual establishment. In illustration it will suffice to give the average rate of roughers' wages at different periods, as follows:—

ROUGHERS' RATE.

Roughers' Wages.

1855—1s. 2d. per cwt. = 13s. per week; 1865—1s. 4d. per cwt. = 15s. per week; 1875—1s. 9d. per cwt. = 19s. 6d. per week; 1884—1s. 7d. per cwt.—17s. 6d. per week.

CHAPTER IV.

FLAX HACKLING MACHINES.

The second process of dressing that flax undergoes is the splitting or reducing of the fibres to the finest condition they are capable of assuming without detriment. This splitting or "Machine Hackling" is performed by machinery of various constructions, among the most recent and best being "Horner's Patent Duplex Vertical Sheet Hackling Machine." This machine, as its name indicates, differs from the older machine of the flat or inclined sheet type, which was single.

Horner's Vertical Sheets.

The vertical sheet admits of the fibre being thoroughly split or "cut" without the tearing or snapping liable to occur where the flax is not entirely raised off the pins during the passing of the "holder" from one shift to another; and its being double allows the pin to act on both sides of the flax at once, instead of having to undergo the turning process so injurious to it, as practised on the older style of machine.

The pins of Horner's "sheets" can be made to intersect on the upper side, so that when the "head" lowers the flax down between the sheets, it is gradually hackled by the points of the pins shooting into it from both sides at once.

Variety of Hackling Machines.

The hackling machines in an establishment should not be all similar; if there be but three, there should be a coarse, medium, and fine machine, because no matter how well flax be bought, there must of necessity be a great difference in the various lots.

Machining the Flax.

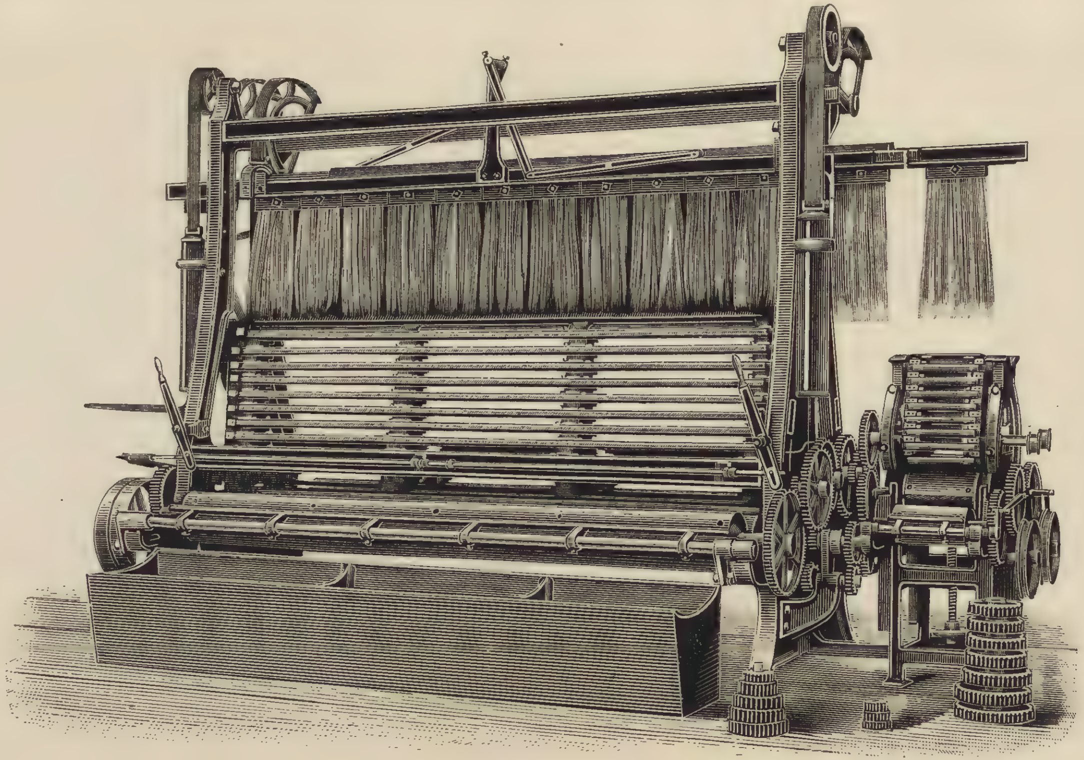
A "parcel" being brought to the machine to which it has been assigned, the boy, who sees to the supplying of the machines, gives the machine boys "shorts" to put through first, because, the last of the parcel just being finished having only left the table, but being still in the machine, there must be some distinguishing mark between the two parcels; and the shorts are different work. But suppose the flax is machined by the lot, then the separating mark may be an empty "holder" put in after the last piece is completed. When this first holder of shorts, or the empty one, is coming forward over the finishing head, the boy knows that it is the last of a parcel, and raps with his holder-wrench for the "tippler" to come and square up.

The Tippler.

The "tippler" is a boy who attends to the machines, and when about ten pounds weight of flax off the machine is lying in the stool, he comes, and, drawing the loose fibres of each of the four corners of the flax in the stool, called a "tipple," laps the corners therewith, and so renders the tipple a compact square-looking bundle of flax like a pillow.

Tipple of Flax.

This the boy puts into the basket which contains the particular parcel of which this is the last tipple. It must not be supposed that the boy feeding the machine has to call the tippler every time his stool is full of flax. The latter gets into such a swing of work that he always manages to come up to the machine that has most flax before it is ready to be tippled, and it is only when a parcel is coming off, and when perhaps there may not be two pounds in the last tipple, that the tippler has to be called.



HACKLING MACHINE.

When the last tipple of the parcel is finished, the basket is brought to the scales, and its gross and nett weight taken, the latter showing the actual weight of machined flax or "longs" obtained from the two hundredweight. The boy who attends to the baling of the tow from the machine, seeing the parcel off, brings the tow to be weighed by the parcel boy, who enters the amount on the ticket as so much No. 1, No. 2, No. 3, and No. 4 tow, this being the manner of assorting the qualities. To show the importance of this precaution, we may remark that cheap tow "rises" on the four sorts, and on the roughing and sorting tow, from 2s. to 3s. per cwt.; and on the finer and dearer tows, from 4s. to 6s. per cwt., we having seen the latter selling at the following figures in brisk times:—

Weighing the Longs.

Machine Tows.

FINE COURTRAI TOW.

R	1	2	3	4	Stg.
58/-	64/-	68/	72/-	78/-	84/- per cwt.

Parcel Boy.

The parcel boy adds the yield of flax and the machine tow together, and if all has been kept separate, and correctly weighed, the sum total should be within a pound or so of the flax weighed in from rougher, so that we soon have the parcel ticket half filled out, and showing the exact amount of tow and waste made up to this time. The mode of feeding the flax into the machine is as follows:—A boy called a "filler" lifts two pieces of flax off the rougher's bunch before him; these he spreads upon a sort of iron plate, 11in. long by about 4in. broad, with a strong screw or bolt fixed firmly upright in the centre of this "holder," as it is called. One piece of flax is spread on each side of this screw, so that each piece is spread over about four inches, with about one foot in length of the flax hanging clear of the holder, this length being the "root-end" of the piece, which is passed through the machine first.

The Filler.

The Holder.

The Root-end.

The flax is held, as if in a vice, by a top plate being dropped upon the holder plate, and screwed up with a nut. To make the grip of this holder secure, the inside faces of the plates are covered with corrugated indiarubber, or flannel.

The Channel.

The holder being filled with flax, the boy (who is called a "filler") lifts it off his table and puts it into the head, or "holder channel" of the machine. This head is a lifter working horizontally over the "sheets," slowly rising and falling about eighteen inches, or any other distance desired, according to the length of the flax. Inside the head or channel is a rack working upon a slide. The rack, by means of detents, catches the holder as soon as it passes into the channel, and shifts it, each time the head rises to its full height, the length of a holder—eleven inches—so that when the "head" again lowers, the flax passes as usual between the two vertical sheets, but into a finer set of hackles.

Shift of Holder.

The Machine Tools.

These sets of hackles are called "tools," and the number of tools to each sheet varies according to circumstances. There are six, eight, nine, ten, and twelve-tool "Horner's Machines," the breadth of tool or "stock" varying from $8\frac{3}{8}$in. to $11\frac{1}{4}$in., according to the number to the "sheet," as the over-all length of a Horner's machine does not vary more than one foot, say from eleven to twelve feet. The finer machines having the most tools—of the shorter stock—are slightly the longest.

If a machine be six-tool, six lifts of the head throw out the holder on the opposite side, with half the flax hackled; if an eight-tool, eight lifts, and so on.

The lifts of the heads are performed by a strong horizontal lever or arm working on a centre stud, and at right angles to the heads, but below the latter. A few inches from the centre of the stud upon which this lever rocks, there is a strong iron pin fixed in the side of the lever, and at right angles to it. A piece of iron called a "runner" encircles this pin, and is confined in a groove cast in the side of the large wheel facing up close to the front of this pin, which is called the "wiper," because in its revolutions it causes the runner to wipe or bear on the side of this circular groove, and thus, according to the shape of this groove, is the runner lowered or raised as the wheel slowly revolves.

The Machine Heads.

The pin, which is a fixture in the lever, being contained in this runner, the desired rotating or rocking motion is communicated to the lever. The "head slides" are resting upon the ends of this lever, and are thus alternately lowered and raised. The shifting of the holders is effected by a differently shaped groove, cast on the outside of the wiper. In this groove a runner travels, as already described, but is in this case connected with the extremity of an upright lever by a pin fixed in the latter. This lever has in the middle of it a V bend, the vertex being held in one position upon a strong pin set in a "stud bracket" screwed to the gable, between the "sheets." The other extremity of the lever branches into two arms which are connected with the rods working the detents in the slide, or channel. Thus is the same rotating motion given to the double-armed lever working the rods, as is given to the lifting of the heads, with this difference, that the outward or shifting motion is given to the rod for drawing the holders when the head is at its height on one side of the machine, and as the other head will then be at its lowest, so does the outward motion of the rod on that side only carry the detents back one set of holders, to be in readiness to push the holders forward towards the other end of the machine when the head rises.

As there is a detent for each tool, and a holder in the channel to each detent, it is plain that every shift of the holders throws one out on the opposite end of the machine. This holder as it is passed out of this head, is lifted down by a boy called a "changer," who, laying it flat on the table in a bed made to receive it, allows the hackled portion of the flax to fall evenly over another "holder" lying open in its bed ready to receive the hackled end.

The Changer.

The beds of these two holders are set so far apart that on the hackled portion being screwed up in the latter holder, and the former one removed, there may be enough of the hackled portion of the flax on the same side of the holder as the unhackled, so that on its being put into the other head of the machine, the fibre on passing down between the sheets may be thoroughly cut up into that already operated on and right into the heart of the piece. Thus there is a certain amount of shift, say two inches, necessary to the proper cutting of the fibre.

The Top-end.

Overshift.

The sheets of a hackling machine are composed of bars of iron the full length of the machine between the gables, and about one inch broad by a quarter inch thick, screwed to endless leather straps, at each end, and in the centre of these bars.

The Machine Sheets.

These straps are about $5\frac{1}{2}$ feet in circumference, and are stretched over bottom and top rollers, revolving between the gables. The bottom roller is that which gives motion to the sheet, the top one is merely a stretcher or carrier.

The Sheet Rollers.

The bottom roller is usually about nine inches in diameter. It has iron bosses on its ends and centre, which have

Catches. catches cast on their surface. These catches bear upon the straps and bars, and so the sheet revolves with the roller.

The Hackle Stocks. The hackling stocks are screwed on to these bars, forming an endless revolving sheet of steel pins. Cast in the sides of this centre boss, and on the inside of the two end ones, are notches or grooves; these are for containing the stripper rods, Stripper Rods. which are plain pieces of tough pliable wood, as spruce, about $1\frac{1}{2}$in. broad by $\frac{1}{4}$in. to $\frac{3}{8}$in. thick. Cast-iron ends, called stripper cocks, are riveted on the ends of these laths, making their length the same as the distance from the inside of the grooves on the end bosses to the corresponding groove in the side of the centre boss. When these stripper rods are sprung into their place in the grooves, they have freedom to play in them, shooting out level with the points of the pins as they are carried round towards the under-side of the roller, and falling back of their own weight as they are brought round to the top. The shooting out of these rods knocks the tow off the hackle pins on to a tow catcher Tow Catcher. facing close up to the stripper rods. This tow catcher is upturned each time the head descends, throwing the tow off into boxes below the machine.

As previously stated, the top rollers are merely for bearing the sheets. They work in brasses, which are set in slots cast in the gables of the machine. These brasses are kept stationary by being connected with powerful screws working in the frame work; it is by turning these screws The Intersection. that the intersection of the pins is regulated. The working of the intersection is a matter of great importance in machining, as it is influenced by the speed of the sheets; quality of fibre; size of piece, and cut required. The amount of intersection also depends, to some extent, upon the rigidity of the sheets, as they have a tendency to expand from centrifugal force.

Separate Intersection. If the root end of any flax be much thicker than the top, the intersection of the head, over which the root passes, can be specially regulated. In altering the intersection, it is of the greatest importance that the line of pins be exactly Setting a Hackling Machine. parallel with the line of the head, and that the centre of the intersection be plumb with the line of holders, as they lie in their channel.

Some persons work without any intersection, but merely a facing-up of the pin points. This course is adopted when a large turn-off from the machines is sought, by driving them up to their greatest speed. Others, more particular about the "cut" and appearance of their flax, look for less turn-off, and sometimes work with even $\frac{3}{16}$ of an inch of intersection on the fine end.

Separate Speeds of Sheets. If it is necessary to give one end of flax more work than the other, from prevalence of "naps," &c., the speed of sheets of Horner's newest make can be altered separately to meet the requirement.

Another hackling machine, fast coming into favour, is Cotton's Machine. Cotton and Company's. This machine differs materially from Horner's in some points. For example, Cotton's is composed of, as it were, two machines set side by side, there being only one head and one pair of sheets to each machine. Thus, a pair of these machines takes up nearly double the room, and requires nearly double the power to drive that Horner's Duplex does.

On the other hand, Cotton claims as an advantage derived Slaving the Fibre. from the adoption of his machine, that the fibre is less "slaved" and broken in the machining process, as the pins

are longer and yield more when in contact with the flax, gradually combing and levelling the irregularities and matted portions until they are straightened so as to be in readiness for the splitting of the fibre. From the specification of this patent we learn that Cotton aims at securing the above-mentioned advantage, not only by an extra length of pin but also by fixing the hackle-stock to the inside face of the hackle-bar, that is to the face nearest to the rollers. He makes the stock broad enough to project beyond the top edge of the bar, so that the hackle teeth or pins which are carried by the top portion of the stock shall be clear of the bar. Or the hackle-bar may have arms or pieces attached to it to project above the top of the bar, so that the front face of such arm shall be level with the back of the bar. By this means, when the hackle-stocks are fastened on the face of the aforesaid projecting arms, the root of the hackle-pin will rest on the endless leather or other sheets to which the hackle-bars are attached. Intersecting hackling machines have been made where the back of the hackle-stock rests on the endless sheet aforesaid, but they have been where no hackle-bar has been employed. The object of the above improvement is to bring the hackle closer to the centre of the top sheet roller, and therefore nearer to the nip or bite of the holder during the operation of hackling.

Cotton's machines are supposed to produce a better quality of tow off the same flax than Horner's stripper rod machines, as Cotton adopts the old style of stripping by brush and doffer, so that the tow is not napped and slaved as it sometimes is by the method of stripping it off the pins adopted by Horner. The arrangement is a quick revolving brush roller, cleaning the tow off the pins of the sheet. The tow is then taken from the brush by means of a revolving roller clothed with coarse card clothing, the pins of which retain the tow as it is laid on to them by the brush, until it is doffed or knocked off by means of a serrated blade which faces close up to the roller and receives its beating or rotating motion from an eccentric driven from the gearing.

Stripping the Machine.

Brush and Doffer.

The brush and doffer principle can be credited with another decided advantage, viz., that with it there can be more pins per inch in the finishing tool, as it is found that after a certain degree of closeness of pin is reached in Horner's stripper rod machines the pins become clogged with a peculiar resinous gum that is given off by the finer qualities of flax, especially courtrai. This gum the stripper rods are powerless to remove, but it is kept in check by the brush. In his finer and cut line machines Horner has therefore had to adopt the brush and doffer arrangement to keep the pins clean ; but his machines being duplex renders the mechanism of these very inaccessible owing to want of space. Consequently there is often trouble with Horner's brush and doffer. But in neither machine is the brush and doffer a sure preventative of the gathering of this gum, as it will accumulate more or less on that side of the pin with which the brush does not come in contact. Then the brushes are very destructive to the pins, once they begin to get short with wear and become clogged with dirt at the bottom of the staple. This evil is all the more observable where there are two rows of pins per stock to be kept clean, as should be the case with all machine hackles.

Clogged Pins.

Horner's Brush and Doffer.

Mr. Cotton thought he had made a decided improvement in machine hackling by adopting three more open rows of pins in the hackle instead of, as previously, one or two closely set, until he found he could not keep them clean, and so had to relinquish the idea.

Rows of Pins in Stock.

However, we have much pleasure in stating that the question of how to keep the pins of the hackling machine clean, has recently been solved by Mr. Robert W. McDowell, manager of Brookfield Spinning Mill, Belfast. So much is Mr. McDowell's invention the very thing desired by Mr. Horner, that the latter was not long in securing the patent right in this and foreign countries from the inventor. We cannot do better than describe this invention in Mr. McDowell's own words :—"My invention is applicable principally, but not exclusively, to those hackling machines in which vertical sheets and stripper rods are employed, such as those known in the trade as Horner's Stripper Rod. It may be attached to other makes of machine. My invention substantially consists in the application to such machines of a revolving brush, the motion of which is capable of being reversed so as to clean itself. For this purpose I provide, preferably, a spiral brush, which revolves in the same direction, and quicker than the pins of the machine, so causing the brush to pass through the pins and remove any gummy or fibrous particles adhering to them. At regular intervals, say when the head or channel of the machine rises, the brush is made to reverse its motion, and slowly revolve one or more times in the contrary direction, thus meeting the pins and allowing them to carry away any fibre that may stick on the brush, and which fibre is deposited with the tow. By means of this improvement the pins are kept cleaner than by what are called the brush and doffer machines, as in the latter the brushes only clean the back of the pin, leaving the cutting side dirty, but by the use of my invention, all the cutting parts of the pins are kept perfectly clean. I am aware that the revolving brush is not new, but as applied to stripper rod machines and reversing as aforesaid, it is claimed to be new. The gearing mechanism for producing the reverse motion of the brush may be varied, but a convenient arrangement, and such as I have found to answer, is as follows :—There is a wheel on the end of the bottom shaft of machine driving the sheets, into which wheel works a small pinion with clutch gear, and loose on the brush shaft. The corresponding clutch slides on a key in the brush shaft, which latter has a wheel fast on end of brush shaft, and working outside the wheel on the bottom shaft and pinion. There is another wheel fast on a socket working on a stud fastened to gable of machine, and is geared with wheel on the brush shaft. On the same socket there is also a loose wheel with clutch, the corresponding clutch sliding on a key in the aforesaid socket, and the latter wheel is in gear with the wheel on bottom shaft. The two sliding clutches are worked by a small lever or rod working on a pivot equidistant from each other. When the clutch is fast in the pinion the brush is driven with the pins, but when the head lifts, the lever, which may be fixed either to the head or to the tow catcher, throws out the clutch and throws in the other, which causes the loose socket wheel to become fast on the socket, and as the corresponding socket wheel is fast on same socket, it revolves in the same direction; the wheel on end of brush shaft being in gear in the first socket wheel causes the brush to revolve in the opposite direction from what it did in the first instance."

Unclogged Pins.

Comparison of Hackling Machines.

It is open to doubt whether Horner's or Cotton's machines give the sounder fibre, but hitherto the latter machine produces the best tow.

Cotton's machines make far less noise when working, as there is not the incessant dropping of the iron shod stripper rods in their sockets. Horner's machines are more compact and not quite so expensive to keep in order, on account of the shorter pin.

We shall now give the different calculations and speeds relating to a hackling machine.

Horner's Patent Eight Tools.

For good class of Irish, Flemish, French, and Bruges, "Long Line" flax.

Speeds of Hackling Machine.

Speed of driving shaft........	130	revolutions per minute.
	18	inches diameter of drum.
Diam. of pulley—inches 19)	2340	
	123·16	speed of pulley.
	20	teeth in sheet pinion.
Roller wheel teeth........70)	2463·2	
	35·19	speed of bottom roller.
	15	catches on roller.
Bars in sheet..............30)	527·85	
	17·59	speed of sheets per minute.
	123·16	speed of pulley.
	28	teeth in head pinion.
Head wheel teeth ......100)	3448·48	
	34·48	
	14	teeth in stud pinion.
Wiper wheel teeth........94)	482·72	
	5·13	lifts of head per minute.

Pins passing through Fibre.

From the above speeds it will not be difficult to calculate the immense number of pins that pass through the flax in a minute, when taken in conjunction with the following particulars of the same machine. Circumference of "sheet," 62 inches.

Gradation of Tools.

Tool.	Pins per in.	Rows of Pins.	Wire Gauge.	Length of Pin.
1	¼	2	14's	1 inch over all.
2	½	2	15's	1 ditto
3	1	2	16's	1 ditto
4	2	2	17's	1 ditto
5	4	2	18's	1 ditto
6	6	2	19's	1 ditto
7	10	2	21's	1 ditto
8	15	2	23's	1 ditto

Length of hackle stock.................... 11 inches.
Breadth of hackle stock .... 1 inch.

Cut-line Flax.

Such being the particulars of a "Long Line" machine, it may be well here to give that of one for "Cut Line," but, before doing so, let us see what "cut line" is.

When very superior flax is required for the finest yarns, it is procured by taking the best of the rough flax and cutting the two ends off; the ends being always the worst portion of the flax. This leaves a pure "middle" of from 12 to 18 inches in length, according to circumstances. Out of very long flax two middles may be taken of from nine to 12 inches long; these very short "middles" being required for only the very finest machinery, or where the flax is so sound and long that there would be waste in taking only one long middle, and thus throwing too much pure fibre into the ends.

The ends are never so well dressed or prepared as the middle, and so are not spun to nearly so fine numbers, which causes a waste of such pure fibre as may be left in them.

Flax may be too short to get more than one middle of the requisite length, and one end, or it may be as sound in one end as in the middle, thus necessitating the removal of only the inferior end. These two latter cases are called taking the "long middle" out of flax.

Again, it is sometimes found advantageous to take a sound middle and one good end of flax, of which the other end is " nappy " or " birsy," and to cut off the latter as short as possible and send it straight to the cards to be carded into tow. The "roughing" of flax which has to be converted into "Cut Line" is usually performed differently from that of "Long Line," the pieces being made a great deal larger, and getting a mere draw over the pin points to level the fibre. This style of roughing is called "stacking," and Courtrai flax is principally treated in this manner.

The reason for the pieces being made larger is that the fluted rollers of the breaking machine, or "cutter," get a firmer hold of the piece as it is passed in to be broken or "cut," it being thus broken square in the end, with no dragged fibre. The cutter boy can hold and guide the large piece under the fluted pressing rollers, and get through a much greater quantity than if the pieces were of smaller size.

As the fibre is broken by the cutter, the short pieces are pieced out into suitable sizes for undergoing the machining, by boys, who soon become as accurate in performing the operation as a "rougher" himself would be.

The Flax Cutter. The breaking machine, or "cutter," is composed of a set, or two sets, of iron fluted rollers, resting on gables, and enclosing a revolving circular blade, also supported between the gables. A velocity of from 700 to 1,000 revolutions per minute is communicated to the cutter, which is of the following construction:—Three wrought-iron or steel rings are firmly bolted together between two flanges. The rings have projecting points placed at regular intervals on their peripheries, so disposed when they are bolted together as to present diagonal groups of cutters, diamond-shape—all round the circular cutter—projecting about $\frac{5}{8}$ths of an inch. The revolving blade is enclosed by the slowly revolving fluted rollers, and it is they that carry in and hold the flax until it is severed by the cutter.

Horner's Patent Twelve Tools.

Cut Line Machine. For fine "Cut Line" Flaxes. Circumference of sheet 42in.

Tools.	Pins per inch.	Rows of Pins.	Wire Gauge.	Length of Pin.
1	$\frac{1}{4}$	2	14s.	$\frac{3}{4}$in. over all.
2	$\frac{3}{8}$	2	15s.	$\frac{7}{8}$in. ,,
3	$\frac{3}{4}$	2	16s.	1in. ,,
4	1	2	17s.	1in. ,,
5	$1\frac{1}{2}$	2	18s.	1in. ,,
6	3	2	19s.	1in. ,,
7	5	2	20s.	1in. ,,
8	8	2	21s.	1in. ,,
9	12	2	22s.	1in. ,,
10	17	2	23s.	1in. ,,
11	23	2	24s.	1in. ,,
12	30	2	25s.	1in. ,,

Length of Hackle Stock, 8in.
Breadth ,, ,, $\frac{7}{8}$in.

Relative Speeds of Sheets and Heads There is great diversity of opinion concerning machine hackling. Some authorities prefer a great many pins per inch, slow sheets, and quick heads. Others fewer pins per inch, quick sheet and slow heads. Others are for having many pins per inch and driving the whole machine as slowly as possible.

The following may be taken as a fair statement of what will give the best results:—About six lifts of head, and sheet 20 revolutions per minute, with finishing tool eight pins per inch, two rows, for six-tool machine, for very coarse long line flax. About five lifts of head, and sheet 15 revolutions per minute, with finishing tool 14 pins per inch, two rows, for nine-tool machine for medium long line flax. About six lifts of head, and sheet 20 revolutions per minute, with finishing tool 30 pins per inch, two rows, for 12 tool

machine, for medium cut line flax. About three lifts of head, and sheet ten revolutions per minute, with finishing tool 50 pins per inch, two rows, for 12 tool machine, for very fine cut line flax.

One reason of the fine machines being so much in vogue is that more speed can be given to the "head," and still put as many pins through the flax as in a coarser machine with slower head, thus increasing the "turn off." Our opinion, however, is that what is gained in this way, is lost by driving the boys so much that they do not get time to level the pieces in the holders, and screw them up tight enough, thus causing a great loss in "yield," by slipping fibres and uneven cutting. Also, the boys will change to where the work is lighter, the first opportunity; it costs more to keep the hackles and holders in order; the machine is more quickly run down; and lastly, the same free open cut is not procured as when there is more moderate speed on the head.

The sheets may be driven at a fair speed to split the fibres instead of tearing them, and to accomplish this the hackles need not be too fine.

A coarse machine will give excellent results on fine work by driving the heads and sheets dead slow, say two-and-a-half to five revolutions per minute, respectively. This will not diminish the "turn off," when compared with a finer machine, as much as might be expected, there being fewer shifts to throw the flax out of the head.

We have known of two pairs of Horner's Duplex Cut Line Machines being converted into one pair of machines, for very fine work, by being placed end to end, and the holders shifted from one into the other by a special arrangement. Results of this quadruple machine were excellent, the graduation of tools being so regular and complete as to effect the thorough splitting of the fibre with a minimum strain.

It is to operate thus gradually on the fibres that we have eight, nine, ten, 12, and 14 tool machines for the better and finer class of flax, where six tools are considered sufficient for a coarse kind. To go beyond 10 or 12 tools on ordinary machines of 11 or 12 feet over all length, would be detrimental, rather than the contrary, to the thorough splitting of the fibres, as the piece would be too much confined within the shortened "holder." Again, to get any sort of "turn off" from a machine with more than 12 tools, the "head" would have to be driven fast. Here also being a disadvantage, as if the flax be let into and drawn from the pins too fast, the strain on, and breaking of, the fibre is increased. This diminishes "yield" and deteriorates quality. Quick drawing of the "head" is also instrumental in putting the small "naps" of a gummy or oily nature into flax. These naps are weak and fine fibres drawn into small hard lumps by too quick feeding of the fibre into pins, that may be coated with a hard sticky substance. This causes the fibre to be drawn or overriden, instead of split. They are only partially removed by the hackles, and if not thoroughly cleaned out in the "dressing" process (sometimes nearly impossible), will destroy any yarn, as the preparing process only tends to increase them. Naps are most prevalent in the top end of flax, which is usually finest, and hangs furthest out of the "holder," thus making the fibre less able to resist the "tear" of dirty pins. They also lie thickest about the extremity of the top end, as they are drawn down by the pins from the heart of the piece, and are left in the extremity where the pin cannot exert the same cleaning power, the "end" being thinner and lighter than the body of the flax. Also, a great part of the time the end is in the hackles it is entirely clear of the pins, as the "sheets" open out from each other on the lower side, so that too many pins may not be in the flax at the same time.

Origin of Naps in Flax.

At the expense of "yield" these naps can be extracted by not permitting the "head" to rise so high as to lift the flax entirely out of the "sheets" at each "shift," but to make the "shift" with the tail end of the fibre in the intersection, this drawing the flax across the pins and cutting away most of the loose flax and impurities.

Eradication of Naps.

There are some kinds of flax of such extremely soft and wefty nature that, to secure a fair "yield" and "open cut," it is imperative to drive both sheets and head dead slow, with light intersections. A quick head, slow sheets, and light intersection will give a "light cut," this being productive of large "yield" at the expense of a raw unfinished fibre. Such a course is often pursued where "big boned" flax is required for coarse lea yarn, but where naturally coarse open fibre is not procurable; but it is not judicious, as if the fibre is not naturally big, this uncut stuff when it comes to be prepared and spun, gives the very worst results. It becomes broken and mashed up under the weighted pressing rollers, causing licking-up and "chokes" in the preparing; and when it comes to be spun produces a poor "hairy" yarn. Besides, as before remarked, it is possible to overdrive the machine boys!

A Light Cut.

Of these, two fillers and two changers to each Duplex machine, is the proper "manning." The tow boys, sweepers, parcel and cutter boys, tippler, oiler, and the "piecers-out," bringing up the complement to an average of about five hands per machine. Fillers have the most important work, and most of it, and consequently should be better paid than the changers. Where female labour is plentiful, women and girls can be advantageously employed in the "machine room."

Machine Room Hands

Hackling machines are costly, a Duplex being from £200 to £300, according to number of tools and fineness. They are also expensive to keep in order, the pins requiring incessant overhauling, as they are much torn up by the lumps, knots, and loops in the flax, but close supervision of the roughers and machine boys will mitigate this evil. The wear and tear of the hackling machine is pretty heavy; channel ends, holders, bars, straps, stripper cocks, runners, catchers, brasses, etc., etc., requiring frequent renewing.

Price of Hackling Machines.

Repairs to Hackling Machines.

The rate of wages to machine-room hands, at different periods, has been as follows:—

Wages in Machine Room.

	1855.	1865.	1875.	1884.
	s. d.	s. d.	s. d.	s. d.
Tipplers	0 8	0 10½	1 2¼	1 1
Fillers	0 7	0 9½	1 1¼	1 0
Changers	0 6½	0 8½	1 0½	0 11½
Sweepers, etc	0 6	0 8	0 11½	0 11

per diem, for "full time" per week.

CHAPTER V.

FLAX DRESSING AND SORTING.

THE third process that the fibre undergoes is dressing and sorting, performed by hand. The fibre is very fairly "cut" on coming off the machines, but, to give it justice, it must be pulled through a coarse hackle called a "ten," broken, and then cleaned out over a fine one called a "switch." This is done by men thoroughly versed in the dressing process. These men have also to use their judgment as to the capabilities and qualities of the piece dressed; in fact, to assort the flax, piece by piece, into various bunches.

The third Process.

A "Ten."

A "Switch."

Hacklers.

This process should be performed by none but men who have served an apprenticeship to this branch of the business, and who have proved themselves not only good hacklers, but intelligent sorters.

Apprentice Hacklers.

Apprentice sorters can be brought forward on the very coarsest work, flax so poor as not to be worth the expense of skilled dressing, or so easily manipulated as are the short ends off cut line flax. This class of work needs little more than to be bunched, without being broken; after a pull or two over the ten, and a finishing rub over the switch. In the case of long line, it goes by the the name of "touch 'im," and in cut-line, of "ends." Some slight knowledge of sorting is necessary in the hackling of ends. About twice as much material can be treated in this way, in a given time, as can be hackled if the flax has to be broken. Girls and women can be employed on this work.

Hand-dressing the Fibre.

These two modes of treating the fibre must not be confused with the ordinary "Hand-dressing," which is hackling the flax entirely by hand. The machines have, generally speaking, superseded hand-dressing, from their being so much more expeditious and labour-saving. But in small out-of-the-way places, where labour is cheap, hand-dressing is still resorted to. It is also employed when the soundest fibre is necessary—as for thread-spinning—as the strain on the fibre can be regulated to suit circumstances better than can be accomplished on the hackling machine. Hand-dressing is simply a combination of roughing and sorting, performed by the operator over three or four tools ranged before him. The work is tedious, one hackling machine being able to get through as much work as twenty hand-dressers.

Proportion of Operatives to one Machine.

It takes four roughers to supply one machine with roughed flax, and about seven sorters to dress the "longs" from same.

Flaxes to be Hand-dressed.

Flax of poor quality, but comparatively clean on account of the "shove" being brittle and well retted from the fibre, as Riga, Pernau, or indeed all Russian flax, coarse Dutch, Irish hand-scutched, and odd lots of "blashed," or water-slain Irish mill-scutched may, with advantage, be hand-dressed. The reason of this is that the pieces can be made larger than if they were being prepared for the machines, consequently there is not the same amount of strain on each individual fibre. Thus the large piece has the advantage of tending to give better "yield," and is not detrimental in hand-dressing, as the pins of the

SORTERS' BERTHS.

hand-dresser's tools are long enough to permit of the thorough working of the piece to the heart, as well as up to the hand. This is very important and can be effected in hand hackling, but not so completely on the hackling machine, from the shortness of the pin. As there is no dirt in the pieces, except a loose shove which may drop out in the work, poor brittle flax treated in this manner can be well levelled and fairly cut, with a fair yield. If the same class of flax had been put over the machine, the pieces must have been made small to allow of the fibre being cut to the heart, thus causing the "slaving" of the flax, which results in loss of yield. Poor flax is "fosey" and light, as well as brittle, consequently there are more pieces to the pound weight, which implies loss in the "turn-off."

Hand-dressers' Rate.

Hand-dressers are paid by the cwt., say from 4s. to 5s. 6d. for the ordinary qualities, but for fine, strong, even flax, specially prepared for making thread, as much as 9s. per cwt. has been paid. For thread there is scarcely any flax having the same strength as Friesland, at least for the coarser numbers. But this flax requires peculiar care in its mode of treatment, as being watered in the exceptionally low lying districts of this part of the Netherlands; the water is usually brackish, impregnating the fibre with a salt, which makes it very difficult to keep it free from damp. The damp is very injurious to the fibre in the hackling and preparing departments.

Size of Pieces.

The question has been raised whether it is better to piece out all classes of flax, so many pieces to the pound, say nine, as is done in some places; or to piece out all to a certain size in the hand, say about 1in. diameter, loose twist. Stating results may best answer this question. In piecing out flax so many pieces to the pound, the poorer the flax and the shorter, the larger will be the piece, and the finer and longer the flax the smaller the piece, which is very satisfactory for all parties, so long as there is a sufficient number of machines of different "sets," so that the poor and large piece may not get too much of the pins, nor the good and small piece too little. By piecing to the pound, there will be also more work got off the machines. In piecing out by size in the hand, the roughers become more expert and exact from force of habit; and there will be a better check upon them if they try to practise the too common trick of making the pieces as large as possible, to admit of their "putting-in" their parcel sooner. When the pieces are all of one size, it is also possible to work with less frequent alteration of the "set" of the machines, and consequently with fewer of them, the changing of "sheet" and "head" pinions being usually sufficient for the different qualities of flax, as there is always the same thickness of flax body between the pins. But there will be a loss in the turn-off by this system, as there may be half as many more pieces to the pound in the case of poor short flax as in that of hard long flax.

The Dressing Process.

But to proceed to technicalities: As previously mentioned, the total pounds of machined flax are entered on the parcel ticket, under the head of "longs," and the parcel is passed over to the sorting shop. The hackler gets it, and commences the dressing of a piece by lifting one from the "tipple" spread before him, and throwing its root end on his hackle first. He distinguishes between the top and root end by the colour of the latter, and by its being thicker and usually coarser than the top. A sure way to distinguish the top from the root end is afforded by the "holder" mark on the piece, the mark being nearest the root end. The mark is also a guide in hackling, as the hackler commences by catching the piece close up to the holder mark; he then pulls the end through the "ten" with his right hand, drawing the piece through his left, which latter he keeps close up before the "ten," on a level with the tops of the pins. The delicate pressure of his fingers on

the piece enables the fibres better to resist the strain imposed on them by being pulled through the hackle, and at the same time levels and smooths them, and affords him quick means of throwing the flax back over the hackle. This operation has to be repeated two or three times before he breaks off the end which contains all the coarsest and shortest fibres, and the major portion of tow and dirt.

Breaking the End.

The end is broken off by the hackler catching a very firm hold of the end of the piece between the finger and thumb of his left hand, as he draws it through the hackle for the third time or so; then by a quick jerk he pulls it out of the hackle, and with it all the longer fibres of tow that are in connection with the end of the piece. He next laps this end of tow and straggling fibres round the "touch pin" once, and in such a way that the end may be lapped without any twist in it. This freedom from twist round the touch pin allows the end to be broken off heavy and square, and with less labour than if twisted. To accomplish this breaking properly is one of the most difficult operations of flax dressing. It is not effected by strength, but by the nicety of the lap round the touch pin, and by holding the right hand (with the flax lapped round the two forefingers, so as to give more purchase on the piece) in the proper position before giving it the jerk to break the piece. This position is with the palm and fingers turned upwards, which allows a straighter and stronger pull than if the hand were held sideways. The straight jerk being given and the end broken off, the hackler lays the latter down beside the touch pin, out of the way, and at the same moment by a continuation of the jerk, and the opening of his right hand, he releases the end of the flax and brings it level over the "ten" again.

The piece must now be well wrought up to the hand, so that the heart may open as freely as the ends, and then, with the left hand, it must be transferred to the "switch." It must here be drawn level and straight from the hand over the pins, turning the right hand (from the wrist only) until all the fibres are perfectly levelled and smoothed by the action of the left hand, and all impurities removed from the heart of the piece. The tow is then "switched" out of the end by holding it still in the right hand, and quickly raising and lowering the end upon the hackle with the left, thus clearing out the remainder of the tow and "shoves" or "naps" that may be in the piece. It must then get the last levelling draw through the hackles, and be caught between the finger and thumb of the left hand as it is leaving the hackle, and, by a twist or catch of the end in the pins in the front of the hackle, receive a crimped and squared appearance on being pulled out of the pins. This is effected by placing the forefinger of the hand holding the end against those pins as a lever on the end, and to support the pins at the same time. The piece must then be turned, and the same operation performed on the top side.

Switching.

Turning the Piece.

On the piece being now turned properly depends to a great extent excellence of workmanship, discernible by the piece opening freely at and being level in the heart. If, on being turned, the shape and position of the piece, as held in the hand, be in the slightest degree altered, the fibres become crossed, and consequently require extra work to be opened back into the hackled portion—in fact, this cannot be thoroughly accomplished even at the expense of time and increased tow. The "expert" turns his piece without allowing it either to expand in the shifting, or to be contracted ever so little on the hand being again closed on it. By turning the wrist of the hand holding the piece both sides can be cleaned out without loosening the grasp on the flax. It is far more important to "switch" and crimp the top than the root of the piece.

We have now the piece properly levelled and dressed, and it is ready for laying upon whichever of the bunches on the table it most resembles in quality and strength. But, before being laid upon the bunch, the piece has to receive the "lap" in this way. It is changed from the right hand to the left without tossing it. Then, with the right hand, a portion of the root end is caught up, say about one-fourth. This portion is between the forefinger and thumb of the right hand, which the hackler draws inwards and upwards, so that this portion of the end may be thrown round the end of the piece in the form of a lap. This lap falls across the piece at the thumb and forefinger of the left hand, the back of the hand being up, so that the piece of flax may, as it were, lie underneath, as well as in the hand. This gives freedom to the right hand to follow or smooth the lap as the portion is thrown over the piece, and at the same time the lap must be pressed against the forefinger of the left hand, so causing a square and firm fold round the dressed flax. The left hand then relinquishes its hold, the piece being transferred to the right hand, the top side of the lap being pressed with the right thumb to keep it in its place. Then, with the aid of the left hand, the hackler lays the piece in its proper position over the other pieces, but a little to the right hand of the last piece on the bunch, so that in this way the pieces overlap each other, growing into a bunch square and firm; which is essential to keep the flax from being tossed, and to permit of the ready lifting of each piece separately off the bunch when it is undergoing the next operation.

The Lap.

When there is the allotted weight, say 20lbs. in a bunch, it is tied up by having four bands passed round it and drawn tight. This system is very injurious to the fibre, compressing it much, and ruffling it, where bands are in contact. For this reason all fine and valuable flax is generally built in boxes, which are very suitable but expensive. Some people put all their dressed line into either paper or cloth covers, but as these have to be tied, there is not much gained by this course.

A Bunch of Dressed Line.

We would recommend some sort of cheap elastic cover, which, on being closed on bunches even of various sizes, would compress the pieces together, keeping them in a firm compact bunch, without any extraneous aid.

Protecting the Line.

This question of how to protect the dressed line cheaply and effectually during the interval between its leaving the flax dresser's hands and being again brought to light to undergo the next process—in some cases as long as two years—deserves more serious consideration than has yet been bestowed on it. But we digress. The reader must not suppose that it takes a tithe of the time to hackle a piece that it has taken us to describe the operation. It is possible to dress two pieces in one minute. An average hackler can dress and sort from 20lbs. to 100lbs. weight of from 20 to 10 pieces to the lb. in the day of ten hours.

Hackler's Day's Complement.

Too much importance cannot be attached to the necessity for careful sorting of the flax, in order to ensure each class and quality of fibre being separated and classified, so that those in authority may always be clear as to the capabilities of the "dressed line." This is a matter of so much difficulty, that seldom, if ever, is full allowance made for difference in spinning quality peculiar to flax grown in different climates and soils. Difference in length, strength, nature, colour, cleanness, and quality may be cited as the chief stand-points from which the capabilities of each piece must be judged. To be able to arrive at a correct conclusion on these points, from the peculiarities developed during the few seconds occupied in the dressing of the piece, should be the ambition of the efficient sorter. To

Classification of Dressed Line.

be able to make use of this judgment should be the desire of the employer. In order to show the difficulties that lie in the way of those who know the importance of a thoroughly assorted and classified Dressed Line Stock, and whose aim is to attain it, we shall state the different methods pursued in different establishments in order to gain this object.

Methods of Classification.

Some persons require their flax buyer to procure, season after season, a range of flax that will be, as nearly as possible, of average similar quality; the poorest of this, on its coming to be sorted, being called by one application—as 30's or 6's, or anything else—and the best, 90's or 18's, etc., the intermediate qualities going to intervening numbers. Others, again, do directly the reverse of this; they buy all before them, putting the worst and cheapest to 30's or 6's, and the best and dearest to 90's or 18's, without any regard to the difference between the flax of different seasons. Some rule much by the locality from which the flax comes and its price, without regard to its spinning quality. And lastly, the commonest and most erroneous of all methods is the attempt to counterbalance defects by good points, and so to do away with the evil of too many sorts.

Now, one and all of these devices must prove signal failures. For instance, where the flax buyer is instructed to purchase nothing but a certain class of flax, this quality may be scarce, or it may be of the quality most sought after by others, and so pushed beyond its value, from the briskness of the demand. Whereas if the buyer had permission to suit his purchases to circumstances, he might procure flax of much finer and better quality for a trifling extra cost, and this would be repaid tenfold by the greater yield. Again, those who go in for the range of the market, without altering their system of sorting to correspond to the change in the season's quality, must obviously have a stock of dressed line varying considerably in spinning quality, when the new and old season's flax are thoroughly mixed. Thirdly, those who sort according to locality and price, must either spoil their yarns or else work on "flax lot" calculations, so erroneous as to be the source of great loss. Lastly, and certainly not least, are the evil effects arising from the fourth method, or that of counterbalancing disadvantages by advantages, thus:—The sorter finds coarse open and fine soft flax in his parcel, and not wishing to lay too many sorts, he puts that flax which is far finer, but not so clean, among flax clean and open, but of much coarser fibre, hoping to counterbalance the defect of the finer flax being a little dirty, and therefore not fit for the finer numbers of clean fibre, by putting it among flax of much inferior quality, but cleaner.

The evil consequences of this plan have daily come under the writer's notice, and he will mention some of them, first remarking that in the cases referred to 30's will represent the very coarsest flax, and 90's the very finest; P, the purest fibre, clean, level, and very strong; 1, pure sound flax, free from "fire tick" or shove; 2, fair warp flax, but perhaps a little fired and shovey; and 3, poor, soft, weak, and even dirty fibre, suitable for weft spinning.

Assuming this classification, he has seen 45·2 among 35 P, because too dirty for 40 P; 55·1 among 45 P, because not quite clean enough for 50 P; 65·1 among 55 P, because too poor for 60 P; and 80·1 among 65 P, because so fine and level as to appear irreproachable, but which would be found, if carefully examined, too fine in the staple for a 65 P, but not strong enough for a 70 P. Then, again, he has seen 45·3 among 30·1, because dirty; 30 P among 35·1, because extra clean; 80·3 among 50·1, because so fine, but not sound enough for 55·1; and 55 P among 65·1, because too good for 60·1. Again, 45·1 among 50·2, because if clean enough, yet too coarse for 55·2; 80·3 among 60·2, because fine, but not sound enough for 65·3; 50·1 among 70·2, because their purity will counterbalance their coarseness, and 75·1 among 90·2, for the same reason. Also 40·2 will appear among 50·3,

because too clean for 45·3; 50·1 among 60·3, because too coarse for 65·3; 55·2 among 65·3, as, though rather good for 65·3, yet too open and coarse for 70·3; and 65·1 among 90·3, as the sorter understands that a very sound piece is requisite to go to that number, but does not consider how much too coarse and strong a 65·1 is for such a class of dressed line as is a 90·3.

Unclassified Fibre; its Evils.

Here we have medium flax merged in prime sorts, poor wefty stuff among warp flax, and good fibre cast in among the poorest, by the sorter attempting to set off fineness against dirt, and cleanness against fineness, etc., etc. In fact, it is usual to find as many as four distinct and different qualities and sizes of fibre in a single bunch of dressed line.

What have we as the result of this widespread and pernicious system? We cannot produce fairly coarse numbers of yarn in many instances to cover cost, from all the coarse poor flax having been pushed to the lower weft numbers, for which it is so much too big in the "bone" as to produce nothing but a poor "shirey" yarn, and this with the worst possible turn-off, and increased waste.

We cannot get flax of the requisite fineness of staple to spin to advantage the finest counts of yarn, unless by going to enormous expense in specially procuring it, as all the finer bits have been put back to coarser sorts, in order to keep the latter "up to the mark," and to prevent the trouble of having too many sorts, or to guard against the risk of careless hackling being noticed, where the fineness of the sort requires it to get every justice. The same reasoning applies to all the different sorts and classes of flax, and in part explains what will be exemplified further on; that it is in the extreme counts of yarn—very coarse or very fine—that most money is to be made, as the prices paid for these yarns are disproportionately higher, on account of the little competition existing in the ends of the trade.

To sum up, our warp yarns are destroyed by being adulterated with inferior stuff, and our weft yarns damaged by being partly composed of rough strong fibre, too big for the class of yarn required, and too strong to work sweetly with the softer and weak nature of the material in general.

Correct Classification of the Fibre.

We shall now place before our readers what we believe to be a solution of the apparently insuperable difficulties in the way of a proper classification. It will be remembered that the necessity for careful selection of the different kinds of flax at the markets—both home and continental—was strongly urged, and it was shown how the different qualities and portions should be marked by tickets so as to be kept distinct. These tickets should not be allowed to drop out of those kinds of flax, that, on their arrival at the spinning mill, have to be taken out of the bales and piled in lots; but should remain in the flax until the time for using or opening the particular lot comes round. The person selecting out the flax will then have no difficulty in thoroughly assorting the bundles or stones, by these tickets. As continental flax is so neatly and compactly put in bales—weighing 2cwt. net—there is no necessity to remove it from these on arrival at their destination; so foreign flaxes are generally left in the bales, and these piled in lots. Therefore the portions or "heads" in these bales are not ticketed, since the foreigner has, as far as possible, put the different classes of flax in separate bales, filling only a few with the odds and ends. All foreign bales are legibly marked and numbered, and these marks and numbers, with the quantity and prices they represent, carefully copied separately into the invoice sent therewith; so that, even in the case of the bales of odds, there is not the least difficulty in "selecting out."

Home flax being thus carefully classified by ticket in the manner specified, and arranged in piles in the rough flax store; and continental flax being classified according to the numbers on the bales, we have the different classes and colours of flax very fairly separated; as flax bought from one farmer is

usually grown from the same seed, on the same land, and steeped in the same water, and consequently does not vary much in length, strength, or colour.

"SORTER'S RANGE."

P	1	2	3
14	22	28	30
16	25	30	36
18	28	32	40
20	30	35	45
22	32	40	50
25	35	45	55
28	38	50	60
30	40	55	65
32	42	60	70
35	45	65	80
38	48	70	90
40	50	75	100
42	55	80	110
45	60	85	120
50	65	90	130
55	70	100	140
60	75	110	150
65	80	120	160
70	90	130	170
75	100	140	180
80	110	150	190
85	120	160	200
90	130	170	220
95	140	180	240
100	150	190	260
110	160	200	280
120	170	220	300
130	180	240	330
140	190	260	350
150	200	280	380

Then—premising that the sorting of the flax is entirely regulated by the size of fibre, "bone," without any regard to its quality—we have the

majority of the sorters getting parcels all dirty or all clean, all short or all long, all strong or all weak, and generally of one colour. This reduces the number of sorts, and the skill requisite to thorough classification, to a minimum.

Correct Sorting of Fibre.

As yet we only have made provision for the correct laying of the range of sorts—say from 20's or 6's, representing the very coarsest fibre, to 200's or 18's, or any other appellation, representing the very finest fibre—some two dozen degrees of size of fibre. Still there is to be dealt with the fact of the flax being clean or dirty, long or short, weak or strong, etc. This classification must be noted by marks or letters—say, as before assumed, P purest fibre, level, and very clean and strong; 1, pure, sound, clean flax; 2, fair warp flax, perhaps a little mixed and shovey; 3, soft, weak, and even dirty fibre.

Classification by Letters or Marks.

But, say some of our readers, there is nothing new in this system, it is carried out in most places; and we grant that it is so, to the extent that if a sorter get a parcel of prime flax, it—the whole parcel—is dubbed P; if a good parcel, 1; and so on. But what of the mixed parcels which any sorter, in his turn, may get? has he either the ability, inclination, or room, to assort, not only an unusual number of sorts, but three or four qualities of these besides? We maintain not one in ten has the ability, not one in twenty the inclination, nor one in the whole shop the room on his table—if the "berth" be like ordinary berths—to lay one half of the necessary sorts. Therefore is this method, as yet, a method in name only, not in deed.

Mixed Parcels.

To make it a method in deed, we suggest that one or more hackling machines be devoted to the machining of all "odd" parcels; and that a requisite number of sorters of unimpeachable ability and integrity be apportioned to these odd parcels. These men must have berths with tables fully capable of accommodating any number of bunches that can possibly be selected; tables of, say fifteen to twenty feet long, where an ordinary length is eight feet. A reduction of from 10 to 20lbs. per day on the allotted complement will be ample compensation to these sorters for the extra time, intelligence and labour necessary to the laying of so many sorts; whilst the employer will be recouped a hundredfold in the superior levelness of his yarns and the certain curtailment of waste in their production.

Especial Sorters.

Length of Berths

The accurate cost of all dressed line can be calculated by estimating correctly the cost of the raw material, its dressing, yield, and its spinning quality. Poor flax may not be worth half so much as good flax of the same sort or "lea"; a pound weight of say 60's 3, worth 10d., may, if a 60 P, be worth 20d. Consequently, if a lot contain many qualities of flax, it is obvious that some separation of the classifying marks becomes necessary; so that the lot which contains much P and 1 quality of flax may be credited with the extra value that it will have over another lot of the same average lea, but of, say, 2 and 3 quality.

Flax Calculation made accurate.

Now this can be done, and done simply, thus:—Turn to the table of gradation of lea line yarns, Chapter XVIII. Select from this table the line extra weft column as the sorter's No. 3 class, the line light warp column as No. 2 class, the line warp column as No. 1 class, and the line prime warp column as No. P class, we have the result as shown in the table on page 34.

This range includes from about the coarsest to the finest lea of "wet spun" yarn, therefore no concern need make use of any more of this range than is necessary to cover that of their spinning.

PARCEL TICKET.

No. of Lot.	ROUGHER'S NAME.	MARKET.
196	*JAMES GALLILAND.*	*BRUGES.*

No. of Parcel.	Gross Weight.	From Rougher.	Rougher's Tow.	No. 1 Tow.	No. 2 Tow.	No. 3 Tow.	No. 4 Tow.	Total Tow.	Total Waste.	Longs.
22	*224*	*218*	*6*	*2*	*2*	*25*	*26*	*55*	*0*	*163*

No. of Machine	SORTER'S NAME.
4	*WM. DAVIDSON.*

																															Line.	Tow.	Waste.	Tl.
P	14	16	18	20	22	25	28	30	32	35	38	40	42	45	50	55	60	65	70	75	80	85	90	95	100	110	120	130	140	150				
1	22	25	28	30	32	35	38	40	42	45	48	50	55	60	65	70	75	80	90	100	110	120	130	140	150	160	170	180	190	200				
2	28	30	32	35	40	45	50	55	60	65	70	75	80	85	90	100	110	120	130	140	150	160	170	180	190	200	2.0	240	260	280				
3	30	35	40	45	50	55	60	65	70	80	90	100	110	120	130	140	150	160	170	180	190	200	220	240	260	280	300	330	350	380				
P								*4*		*10*																					*14*			
1										*70*	*60*	*4*																			*134*			
2																																		
3																																		
Total								*4*		*80*	*60*	*4*																			*148*	*14*	*1*	*163*

This arrangement of the range of "sorts" will explain itself, as it will be noticed that the better class of fibre—but coarser—comes in over the finer and consequently more costly weft class, so as to equalise the value of the various classes. It may be objected that the quantity of each "class" is lost on account of its being entered under the one heading, that is under the No. 3 or "sorter's range," and that therefore there can be no correct "dressed line stock" kept. The answer to this is a request to remark the sketch on preceeding page of a "parcel ticket" designed to meet this objection.

Improved Parcel Ticket.

Such an extensive range as the above no establishment ever produces, nor has it the means of doing so, consequently only the particular range of any concern need be printed on the tickets of that establishment.

The portions of this parcel ticket in ordinary type indicate the printing, that in italics illustrates the "separating" properties of this arrangement, as there is shown to be 14lbs. of prime against 134lbs. of the No. 1 class in the parcel. This ticket being correctly copied into the "weigh in book," to be referred to, admits of the accurate keeping of "Dressed Line Stock."

The objection may be raised that no correct "average lea" can be made out with this arrangement, as it would be too troublesome to make out each range separately, therefore must the whole be made out under some one, say the No. 3 range, this not giving within a long way of the actual average. In answer it may be stated that although this average lea will calculate much finer than is actually the case, yet is it not misleading, as if it come out too fine, so is the quality much inferior, in fact the desired result of making the different "sorts" and "classes" in the one column the same intrinsic value per pound, is at once effected by this arrangement. Thus it is, that having all the pounds of dressed line in each column—no matter of what difference in lea, or variation of quality—valued at the same price, it is correct to add all together, and make out averages on any range (but the "sorter's" preferable). These "averages" made off one range will be by no means misleading for the others, but will work out for all with very little variation—except in the very finest numbers—when credited with the marketable value per bundle. And, as will be shown, this variation in the finest numbers is actually realised, much more money being made in this end from the disproportionate marketable value of these yarns.

The table on next page will illustrate the correctness of the basis upon which the "sorter's range" is arranged.

In this table the assertion previously made—that the individual "sort" of dressed line capable of producing, with provisos, each and all of the four qualities of yarn assigned to it in the "sorter's range," is of the one intrinsic value per lb.—is demonstrated to be for all practical purposes correct, as the actual cost per bundle will compare favourably with the marketable value in each instance.

Although in this table the calculations are made out on the "average waste per cent. and cost of production per bundle," as nearly as can be estimated, yet for general purposes there is no necessity for sailing so close to the wind, as the calculations of "mixes" can be made upon averages. Thus from 20's to 70's lea line may be safely averaged at 18 per cent. for waste, and 19 pence per bundle cost of production. From 70's to 130's lea line at 13 per cent. for waste, and 31 pence per bundle cost of production. From 130's lea line, up, at 13 per cent. for waste, and about 4s. 6d. per bundle cost of production. In concerns spinning a medium average count of yarns, both line and tow, the mixes are generally calculated upon the broad basis of 20 per cent. waste allowance, and 20 pence cost of production per bundle. As we have introduced the

question of "cost of production," we may here give an average estimate of the various items totalling up these results, even although it may be considered premature at this stage to broach this subject.

	Average Lea 45's.	Average Lea 100's.	Average Lea 200's.
Flax Department	3d.	5d.	4d.
Preparing Department	2d.	4d.	7d.
Spinning Department	3d.	5d.	7d.
Reeling Department	2d.	2d.	6d.
Mechanics, Sundries, Salaries, Interest on Plant, Machinery and Stocks. Also for "Wear and Tear" and Mill Furnishings	9d.	15d.	30d.
	Total 19d.	Total 31d.	Total 54d. per bdl.

ACTUAL COST OF LEA LINE RANGE OF YARNS PER BUNDLE

(60,000 YARDS.)

Cost of Dressed Line per lb.	Per cent. Allowance for Waste.	Cost of Bundle. Production.	Range Prime Warp P	Actual Proportionate cost.	Range Warp 1	Actual Proportionate cost.	Range Light warp 2	Actual Proportionate cost.	Range Weft 3	Actual Proportionate cost.
6d.	26	24d.	7's	20/-	10's	14/7	12's	12/6	14's	11/-
6¼d.	25	23d.	8's	18/2	12's	12/9	14's	11/3	16's	10/-
6½d.	24	22d.	9's	16/9½	14's	11/5	16's	10/3	20's	8/6½
6¾d.	23	21d.	10's	15/7	16's	10/4	18's	9/5½	22's	8/0½
7d.	22	21d.	11's	14/8	18's	9/8	22's	8/3	25's	7/5
7¼d.	22	20d.	12's	13/11	20's	9/0½	25's	7/7	28's	6/11
7½d.	21	20d.	14's	12/6	22's	8/6½	28's	7/1	30's	6/8½
8d.	21	20d.	16's	11/9	25's	8/1½	30's	7/0½	35's	6/3
8½d.	20	20d.	18's	11/1	28's	7/9	32's	7/-	40's	5/11
9d.	20	19d.	20's	10/7	30's	7/7	35's	6/9	45's	5/8
9½d.	19	19d.	22's	10/2	32's	7/6	40's	6/3½	50's	5/4
10d.	19	19d.	25's	9/6	35's	7/3	45's	6/-	55's	5/2
10½d.	18	19d.	28's	8/11½	38's	7/-	50's	5/8½	60's	5/-
11d.	18	18d.	30's	8/8	40's	6/11	55's	5/3	65's	4/10
11½d.	18	18d.	32's	8/7	42's	6/10	60's	5/3	70's	4/8
12d.	17	18d.	35's	8/2	45's	6/8½	65's	5/1	80's	4/5
12½d.	17	18d.	38's	7/11	48's	6/7	70's	5/-	90's	4/2½
13d.	17	18d.	40's	7/10	50's	6/6	75's	4/10	100's	4/-
14d.	16	19d.	42's	8/-	55's	6/6	80's	4/11½	110's	4/0½
15d.	16	20d.	45's	8/1	60's	6/6	85's	5/1	120's	4/1
16d.	15	21d.	50's	7/10	65's	6/5¼	90's	5/2	130's	4/2½
18d.	15	22d.	55's	8/1	70's	6/9½	100's	5/3½	140's	4/3½
20d.	14	23d.	60's	8/3	75's	7/-	110's	5/4½	150's	4/5
22d.	14	25d.	65's	8/6	80's	7/4	120's	5/7	160's	4/8
26d.	13	28d.	70's	9/4	90's	7/9	130's	6/3	170's	5/2½
30d.	12	32d.	75's	10/2	100's	8/3	140's	6/8	180's	5/9
34d.	11	36d.	80's	10/10	110's	8/8	150's	7/2	190's	6/4
38d.	11	40d.	85's	11/7	120's	9/2	160's	7/9	200's	6/10
42d.	12	44d.	90's	12/5	130's	9/8	170's	8/3	220's	7/3
46d.	12	48d.	95's	13/0½	140's	10/1½	180's	8/9	240's	7/7
50d.	13	52d.	100's	13/9	150's	10/7	190's	9/3½	260's	7/11½
54d.	13	56d.	110's	13/10½	160's	11/-	200's	9/9	280's	8/4
58d.	14	60d.	120's	14/2	170's	11/6	220's	10/-	300's	8/8
62d.	14	64d.	130's	14/2¼	180's	11/11	240's	10/3½	320's	9/-
66d.	14	68d.	140's	14/7½	190's	12/3	260's	10/5½	350's	9/3
72d.	14	72d.	150's	15/1¼	200's	12/10	2·0's	10/10	380's	9/7

We can now assort and classify our dressed line to spin the maximum range of yarns to the very best advantage, and each flax lot is fully credited with its good or bad qualities, and this without adding in any way to the work of making up full particulars of the manner in which each lot has "turned out" in its manipulation. These particulars go under the name of "lot ticket."

When the various bunches of assorted flax, that the sorter has on his table, come to be of sufficient size, or when the parcel be completed, they

Bunch Ticket.

must be carefully and expertly tied up and a ticket inserted under one of the bands of each bunch, giving full particulars, thus :—

IRISH.
LOT 116.
50·2.
JOHN COOK.
12/7/79.

These tickets can be either written or block-printed by a boy, who between this occupation, that of "weighing in" the dressed line, and entering the completed parcel tickets into the different books, will find his time fully occupied.

Weighing in the Hacklers.

To prevent mistakes or mixing, the day's work dressed in the shop should be weighed in regularly, but only completed parcels. This is performed by the hacklers bringing up their bunches of dressed line, the breakings or "shorts," and the tow of the parcel, to the scales. The full bunches are weighed to prove them up to the standard weight of the shop (if any), say 20lb. each, the odd bits being taken at what they weigh. The total of these bunches, and the shorts and tow, should tot up to within a couple of pounds of the total weight of "longs" from the machines.

Flax Department (book-keeping).

After the parcel is thus weighed in, the sorter delivers the flax into the "Dressed Line Store," and his tow into the "Tow Store," the hacklers' clerk keeping the parcel ticket, which is now completed, and requires to be entered into the "Weighing-in Book," which shows an account of the dressed line received from sorters, and must balance with the "Flax Book," showing the dressed line sent to mill. This ticket has also to be entered into the "Lot Book" under the heading of the lot to which it belongs, and on the line in the page corresponding in number with that of the parcel.

By this arrangement, if a parcel ticket be entered into a wrong lot, or be lost, there will be the vacant space on the page of its own lot, thus tending to the immediate detection of the error. It is the total of all the parcel tickets of each lot added together that forms the subject matter of the "lot tickets" on which the results of the working of each lot of flax is clearly made out. The spaces or lines are allotted to each parcel by the rougher's name and the quantity weighed off to him being entered in the lot book at the time of the parcel being roughed, the number of the line being marked on the ticket. On the parcel being passed through the hackling department it is time to fill up the vacancy on the page of the lot book.

TABLE OF THE MATERIAL, IN POUNDS DECIMAL, REQUIRED FOR THE PERCENTAGE FOR

Leas.	10	11	12	13	14	15	16	17	18	19	20	21	22
8's	27·5	27·7	28·0	28·2	28·5	28·7	29·0	29·2	29·5	29·7	30·0	30·2	30·5
9's	24·4	24·7	24·9	25·1	25·3	25·5	25·8	26·0	26·2	26·4	26·7	26·9	27·1
10's	22·0	22·2	22·4	22·6	22·8	23 0	23·2	23·4	23·6	23·8	24·0	24·2	24·4
11's	20·0	20·2	20·4	20·5	20·7	20·9	21·1	21·3	21·4	21·6	21·8	22·0	22·2
12's	18·3	18·5	18·7	18·8	19·0	19·2	19·3	19·5	19·7	19·8	20·0	20·2	20·3
14's	15·7	15·8	16·0	16·1	16·3	16·4	16·5	16·7	16·8	17·0	17·1	17·3	17·4
16's	13 7	13·9	14·0	14·1	14·2	14·4	14·5	14·6	14·7	14·9	15·0	15·1	15·2
18's	12·2	12·3	12·4	12·5	12·7	12·8	12·9	13·0	13·1	13·2	13·3	13·4	13·5
20's	11·0	11·1	11·2	11·3	11·4	11·5	11·6	11·7	11·8	11·9	12·0	12·1	12·2
22's	10·0	10·1	10·2	10·3	10·4	10·5	10·6	10·6	10·7	10·8	10·9	11·0	11·1
25's	8·80	8·88	8·96	9·04	9·12	9 20	9·28	9·36	9·44	9·52	9·60	9·68	9·76
28's	7·85	7·93	8·00	8·07	8·14	8·21	8·28	8·35	8·42	8·50	8·57	8·64	8·71
30's	7·33	7·40	7·47	7·53	7·60	7·67	7·73	7·80	7·87	7·94	8·00	8·07	8·14
32's	6·88	6·94	7·00	7·06	7·12	7·18	7·25	7·31	7·37	7·43	7·49	7·56	7·62
35's	6·29	6·34	6·40	6·46	6·51	6·57	6·63	6·69	6·74	6·80	6·85	6·91	6·97
38's	5·79	5·84	5·89	5·94	6·00	6 05	6 10	6·15	6·20	6·26	6·31	6·36	6·41
40's	5·50	5·55	5·60	5·65	5·70	5·75	5·80	5·85	5·90	5·95	6·00	6 05	6·10
42's	5·24	5·29	5·33	5·38	5·43	5·48	5·53	5·57	5·62	5·67	5·72	5·77	5·81
45's	4·89	4·93	4·97	5·02	5·06	5·11	5·15	5·19	5·24	5·28	5·33	5 37	5·42
48's	4·58	4·62	4·67	4·71	4·75	4·79	4·83	4·88	4·92	4·96	5·00	5·04	5·09
50's	4·40	4·44	4·48	4·52	4·56	4·60	4·64	4·68	4·72	4·76	4·80	4·84	4·88
52's	4·23	4·27	4·31	4·34	4·38	4·42	4·46	4·50	4·53	4·57	4·61	4·65	4·69
55's	4·00	4·04	4·07	4·11	4·14	4·18	4·22	4·25	4·29	4·32	4·36	4·40	4·43
60's	3·67	3·70	3·73	3·76	3·80	3·83	3·86	3·90	3·93	3·96	4·00	4·03	4·06
65's	3·38	3·41	3·45	3·48	3·51	3·54	3·57	3·60	3·63	3·66	3·69	3·72	3·76
70's	3·11	3·14	3·17	3·20	3·23	3·26	3·29	3·32	3·35	3·38	3·41	3·44	3·47
75's	2·93	2·96	2·98	3·01	3·04	3·06	3·09	3·11	3·14	3·17	3·20	3·22	3·24
80's	2·75	2·77	2·80	2·82	2·85	2·87	2·90	2·92	2·95	2·97	3·00	3·02	3·05
85's	2·59	2·61	2·63	2·66	2·68	2·70	2·73	2·75	2·77	2·79	2·82	2·84	2·86
90's	2·44	2·46	2·49	2·51	2·53	2·55	2·58	2·60	2·62	2·64	2·66	2·69	2·71
95's	2·32	2·34	2·36	2·38	2·40	2·42	2·44	2·46	2·48	2·50	2·53	2·55	2·57
100's	2·20	2·22	2·24	2·26	2·28	2·30	2·32	2·34	2·36	2·38	2·40	2·42	2·44
110's	2·00	2·02	2·04	2 05	2·07	2·09	2·11	2·13	2·14	2·16	2·18	2 20	2·22
120's	1·83	1·85	1·87	1·88	1·90	1·92	1·93	1·95	1·97	1·99	2·00	2·02	2·04
130's	1·69	1·71	1·72	1·74	1·75	1·77	1·78	1·80	1·81	1·83	1·84	1·86	1·87
140's	1·57	1·58	1·60	1·61	1·62	1·64	1·65	1·67	1·68	1·70	1·71	1·72	1·74
150's	1·47	1·48	1·49	1·51	1·52	1·53	1·54	1·56	1·57	1·58	1·60	1·61	1·62
160's	1·37	1·39	1·40	1·41	1·42	1·43	1·45	1·46	1·47	1·48	1·49	1·51	1·52
170's	1·29	1·30	1·32	1·33	1·34	1·35	1·36	1·38	1·39	1·40	1·41	1·42	1·43
180's	1·22	1·23	1·24	1·25	1·27	1·28	1·29	1·30	1·31	1·32	1·33	1·34	1·35
190's	1·16	1·17	1·18	1·19	1·20	1·21	1·22	1·23	1·24	1·25	1·26	1·27	1·28
200's	1·10	1·11	1·12	1·13	1·14	1·15	1·16	1·17	1·18	1·19	1·20	1·21	1·22
210's	1·05	1·06	1·07	1·08	1·08	1·09	1·10	1·11	1·12	1·13	1·14	1·15	1·16
220's	1·00	1·01	1·02	1·03	1·04	1·05	1·05	1·06	1·07	1·08	1·09	1·10	1·11
230's	·95	·96	·97	·98	·99	1·00	1·01	1·02	1·03	1·03	1·04	1·05	1·06
240's	·91	·92	·93	·94	·95	·96	·97	·97	·98	·99	1·00	1·01	1·01
250's	·880	·888	·896	·904	·912	·920	·928	·936	·944	·952	·960	·968	·976
260's	·846	·854	·862	·869	·877	·884	·892	·900	·908	·915	·923	·931	·939
270's	·815	·822	·829	·837	·844	·852	·859	·867	·874	·881	·889	·896	·903
280's	·786	·793	·800	·807	·814	·822	·829	·836	·843	·850	·858	·865	·872
290's	·759	·765	·772	·779	·786	·793	·800	·807	·814	·821	·828	·834	·841
300's	·733	·740	·746	·753	·760	·766	·773	·779	·786	·792	·799	·806	·812
310's	·709	·716	·722	·729	·735	·741	·748	·754	·761	·767	·773	·780	·786
320's	·687	·694	·700	·706	·712	·718	·725	·731	·737	·743	·749	·755	·762
330's	·667	·672	·678	·685	·691	·697	·703	·709	·715	·721	·727	·732	·738
340's	·647	·653	·659	·665	·671	·677	·683	·689	·695	·701	·707	·713	..
350's	·628	·634	·640	·645	·651	·657	·662	·668	·674	·679	·685	·691	..

PRODUCTION OF A BUNDLE (60,000YDS.) OF ALL LEAS; ANY ORDINARY WASTE INCLUDED.

23	24	25	26	27	28	29	30	31	32	33	34	35	per cent.
30·7	31·0	31·2	31·5	31·7	32·0	32·2	32·5	32·7	33·0	33·2	33·5	33·7	=lb. dec.
27·3	27·5	27·8	28·0	28·2	28·4	28·7	28·9	29·1	29·3	29·5	29·8	30·0	,,
24·6	24·8	25·0	25·2	25·4	25·6	25·8	26·0	26·2	26·4	26·6	26·8	27·0	,,
22·4	22·5	22·7	22·9	23·1	23·3	23·4	23·6	23·8	24·0	24·2	24·4	24·5	,,
20·5	20·7	20·8	21·0	21·2	21·3	21·5	21·7	21·8	22·0	22·2	22·3	22·5	,,
17·6	17·7	17·8	18·0	18·1	18·3	18·4	18·6	18·7	18·9	19·0	19·1	19·3	,,
15·4	15·5	15·6	15·7	15·9	16·0	16·1	16·2	16·4	16·5	16·6	16·7	16·9	,,
13·7	13·8	13·9	14·0	14·1	14·2	14·3	14·4	14·5	14·7	14·8	14·9	15·0	,,
12·3	12·4	12·5	12·6	12·7	12·8	12·9	13·0	13·1	13·2	13·3	13·4	13·5	,,
11·2	11·3	11·4	11·4	11·5	11·6	11·7	11·8	11·9	12·0	12·1	12·2	12·3	,,
9·84	9·92	10·00	10·08	10·16	10·24	10·32	10·40	10·48	10·56	10·64	10·72	10·80	,,
8·78	8·85	8·92	8·99	9·06	9·13	9·21	9·28	9·35	9·42	9·49	9·56	9·63	,,
8·20	8·27	8·34	8·40	8·47	8·54	8·61	8·67	8·74	8·81	8·87	8·94	9·00	,,
7·68	7·74	7·80	7·87	7·93	7·99	8·05	8·11	8·18	8·24	8·30	8·36	8·42	,,
7·03	7·08	7·14	7·20	7·26	7·31	7·37	7·42	7·48	7·54	7·60	7·65	7·71	,,
6·47	6·51	6·57	6·62	6·67	6·72	6·78	6·83	6·88	6·93	6·98	7·04	7·10	,,
6·15	6·20	6·25	6·30	6·35	6·40	6·45	6·50	6·55	6·60	6·65	6·70	6·75	,,
5·86	5·91	5·96	6·01	6·05	6·10	6·15	6·20	6·25	6·29	6·34	6·39	6·44	,,
5·46	5·50	5·55	5·59	5·64	5·68	5·72	5·77	5·81	5·86	5·90	5·94	5·99	,,
5·13	5·17	5·21	5·25	5·30	5·34	5·38	5·42	5·46	5·51	9·55	5·59	5·63	,,
4·92	4·96	5·00	5·04	5·08	5·12	5·16	5·20	5·24	5·28	5·32	5·36	5·40	,,
4·72	4·76	4·80	4·84	4·88	4·91	4·95	4·99	5·03	5·07	5·10	5·14	5·18	,,
4·47	4·50	4·54	4·58	4·61	4·65	4·68	4·72	4·76	4·79	4·83	4·86	4·90	,,
4·10	4·13	4·16	4·19	4·23	4·26	4·29	4·33	4·36	4·39	4·43	4·46	4·50	,,
3·79	3·82	3·85	3·88	3·91	3·94	3·97	4·00	4·03	4·07	4·10	4·13	4·16	,,
3·50	3·53	3·56	3·59	3·62	3·65	3·68	3·71	3·74	3·77	3·80	3·83	3·86	,,
3·27	3·30	3·32	3·35	3·37	3·40	3·43	3·45	3·48	3·51	3·54	3·57	3·60	,,
3·07	3·10	3·12	3·15	3·17	3·20	3·22	3·25	3·27	3·30	3·32	3·35	3·37	,,
2·89	2·91	2·93	2·96	2·98	3·00	3·02	3·05	3·07	3·09	3·12	3·14	3·17	,,
2·73	2·75	2·77	2·80	2·82	2·84	2·86	2·88	2·91	2·93	2·95	2·97	3·00	,,
2·59	2·61	2·63	2·65	2·67	2·69	2·71	2·74	2·76	2·78	2·80	2·82	2·84	,,
2·46	2·48	2·50	2·52	2·54	2·56	2·58	2·60	2·62	2·64	2·66	2·68	2·70	,,
2·23	2·25	2·27	2·29	2·31	2·32	2·34	2·36	2·38	2·40	2·41	2·43	2·45	,,
2·05	2·07	2·09	2·10	2·12	2·14	2·16	2·17	2·19	2·21	2·22	2·24	2·25	,,
1·89	1·90	1·92	1·93	1·95	1·96	1·98	1·99	2·01	2·02	2·04	2·06	2·08	,,
1·75	1·77	1·78	1·79	1·81	1·82	1·84	1·85	1·86	1·88	1·89	1·91	1·93	,,
1·64	1·65	1·66	1·67	1·69	1·70	1·71	1·73	1·74	1·76	1·77	1·79	1·80	,,
1·53	1·54	1·55	1·57	1·58	1·59	1·60	1·61	1·63	1·64	1·65	1·67	1·69	,,
1·45	1·46	1·47	1·48	1·50	1·51	1·52	1·53	1·54	1·55	1·56	1·58	1·59	,,
1·36	1·38	1·39	1·40	1·41	1·42	1·43	1·44	1·45	1·47	1·48	1·49	..	,,
1·29	1·30	1·31	1·32	1·34	1·35	1·36	1·37	1·38	1·39	1·40	..	..	,,
1·23	1·24	1·25	1·26	1·27	1·28	1·29	1·30	1·31	1·32	..	..	..	,,
1·17	1·18	1·19	1·20	1·21	1·22	1·23	1·24	1·25	..	..	..	..	,,
1·12	1·13	1·14	1·15	1·15	1·16	1·17	1·18	..	..	..	..	..	,,
1·07	1 08	1·09	1·10	1·11	1·12	1·13	..	..	..	..	..	..	,,
1·02	1·03	1·04	1·04	1·05	1·06	..	..	..	..	..	..	..	,,
·984	·992	1·000	1·008	1·016	..	..	..	..	..	..	..	..	,,
·946	·954	·961	·969	..	..	..	..	..	..	..	..	..	,,
·911	·918	·926	..	..	..	..	..	..	..	..	..	..	,,
·879	·886	..	..	..	..	..	..	..	..	..	..	..	,,
·847	·854	..	..	..	..	..	..	..	..	..	..	..	,,
·819	..	..	..	..	..	..	..	..	..	..	..	..	,,
·793	..	..	..	..	..	..	..	..	..	..	..	..	,,
..	..	..	..	..	..	..	..	..	..	..	..	..	,,
..	..	..	..	..	..	..	..	..	..	..	..	..	,,
..	..	..	..	..	..	..	..	..	..	..	..	..	,,
..	..	..	..	..	..	..	..	..	..	..	..	..	,,

Another book, to be kept by the hackler's clerk, is the "Dressed Line Stock Book," showing the exact quantity of each quality and sort of dressed line in stock. The transferring weekly of the different totals out of this book to a dressed line stock sheet, for the manager, is essential, so that he can at a glance see the sorts that are becoming scarce, or increasing too rapidly, and make arrangements for the opening up of new lots to meet the emergency, or to supply fibre more suitable for some contemplated mix.

Dressed Line Stock Sheet.

From the hacklers giving good weight in their bunches, or from mistakes in the deducting of the weight of bands returned from the preparing rooms, or other causes, the total weight of dressed line stock is liable to vary slightly, therefore it is advisable to weigh every pound of dressed line in the store—say yearly—and so start on a clear and correct footing. However, it requires some discrimination on the manager's part to do this, as the dressed line imbibes much moisture while lying in a suitable store—one into which the sun's rays never penetrate. This moisture should never be included in the weight, it being all dried out with the friction of the preparing process. If a certain percentage be not deducted from the grand total for moisture there will be a great and misleading increase in the mill waste shown over a period. Ten pounds weight per spindle may be set down as the average dressed line stock giving best results. If there be much less than this there will be confusion in the flax department with small lots, a deficiency of of well-selected stock, and the necessity of sending what there is of it to the mill before it has properly "come to" in the store.

Checking Dressed Line Stock.

Necessary Stock of Dressed Line.

If there be much more than the quantity mentioned, there will be unnecessary expense incurred by loss of interest on so much capital lying idle; and much of the line may be rendered musty and damp from lying too long. Too much moisture in line is prejudicial to the preparing of it, and consequently deteriorates the quality of the yarn.

But if tow be badly wanted, or storage for rough flax, or if provision is to be made against an impending strike, it may be judicious to raise the line stock above its normal average.

A few remarks may here not be out of place concerning the making out of the calculations of a "Lot Ticket." The way to find the actual cost of a pound weight of dressed line is to get the total cost of the lot of flax, including storage, baling, freight and carriage, insurance, commission, and interest of the whole, for four months at 5 per cent. per annum. Subtract from this total cost the marketable value of the tow that is off the lot of flax. To the sum remaining add a certain allowance for the cost of dressing—say from 5s. to 7s. per cwt., according to the quality of the lot. Divide this sum by the total pounds of dressed line in the lot, and the quotient will be the cost of the average sort, per dressed pound. To find the cost of a bundle (60,000 yards) of yarn, which that average sort is suited to make, divide the lea-sort into 240 (*i.e.*, the cuts in a bundle of yarn, with 20 per cent. added for waste allowance); the quotient is the pounds weight that it will take to spin a bundle of that lea.

The Lot Ticket.

The average cost of dressed line per pound, multiplied by the weight of material per bundle, will give the average cost of material per bundle, to which must be added the average cost of producing the bundle of yarn, and the discount allowed, to arrive at a correct conclusion as to the cost of turning out the bundle.

Greater accuracy may sometimes be necessary, therefore we have given the table on the two previous pages.

Waste percentage Table.

But although we have referred only to the mode of finding out the cost per pound of the average lea, the cost of any sort in the lot can be calculated by simple proportion of this aver-

Constant Number for Lot.

age; a short cut being to make use of the constant number of the lot. This number, when multiplied upon any sort in the lot, gives the proportionate value of that sort per pound. This constant number is found

Description of Flax.	Cwts.	At per Cwt.	Yield Per cwt.	Average Cost of Dressing. Per cwt.	Average Value of Tow. Per lb.	Average Cost of Dressed Line. Per lb.	Average Lea.	Constant Number.	Range of Sorts.
Courtrai Cut Line	367·1	170/5	70·66	6/6	d. 8	d. 25·39	s. 65·38	·388	50's to 85's
Pernau Long Line	163·5	67/8	73·96	6/6	4½	9·73	35·08	·277	30's to 40's
Dutch Long Line	839·2	92/6	77·25	6/6	6	12·70	47·71	·266	40's to 55's
Irish Long Line ..	3580·1	90/2	70·07	6/6	6	13·00	42·48	·366	30's to 60's
Courtrai Long Line	2313·8	127/-	70·98	6/6	7	18·55	50·66	·366	45's to 80's
Bruges Long Line	3813·9	94/10	77·00	6/6	6	13·09	46·59	·281	40's to 55's
Total Ticket	11077·6	101/11	73·26	6/6	6·27	14·48	46·66	·310	30's to 85's

by dividing the average lea of the lot into the average cost of dressed line per pound of same, for accuracy carrying out to say 3 points decimal. In illustration of this, and of the comparative value of different kinds of flax

over a period, the author here gives particulars of the total quantities of six different classes of flax wrought during the latter months of 1872, and the first portion of the year 1873, and the results obtained off each (see table on previous page).

Lot Tickets.

On the total ticket, ranging from 30's to 85's sorts, the proportionate value of each will be :—

30	35	40	45	50	55	60	65	70	75	80	85
·31	·31	·31	·31	·31	·31	·31	·31	·31	·31	·31	·31
9·30d.	10·85d.	12·40d.	13·95d.	15·50d.	17·05d.	18·60d.	20·15d.	21·70d.	23·25d.	24·80d.	26·35d.

per dressed pound.

Flax Mixes.

The manner in which the foregoing kinds of flax were mixed, and the lea to which they were spun was as follows :—

Table of Line Mixes.

Calculated upon a 20 per cent. allowance for waste, and 20d. for cost of production per bundle (60,000 yards) "over all average."

Mix for 30's Lea Line Warp at 9s. 6d. per Bundle.

$\frac{1}{2}$ or 4·00lbs. of Irish L.L. 30's at 9·2d per lb. = 36·8d
$\frac{1}{2}$ or 4·00lbs. of Pernau L.L. 30's at 8·3d ,, ,, 33·2d
} 70·0d+20d=7/6 per bundle.

Mix for 35's Lea Line Warp at 8s. 9d. per Bundle.

$\frac{1}{3}$ or 2·29lbs. of Irish L.L. 35's at 10·7d per lb. = 24·5d
$\frac{1}{3}$ or 2·29lbs. of Pernau L.L. 35's at 9·7d ,, ,, 22·2d
$\frac{1}{3}$ or 2·29lbs. of Irish L.L. 30's at 9·2d ,, ,, 21·0d
} 67·7d+20d=7/3$\frac{3}{4}$ per bundle.

Mix for 40's Lea Line Warp at 8s. 3d. per Bundle.

$\frac{1}{4}$ or 1·50lbs. of Pernau L.L. 40's at 11·1d per lb. = 16·6d
$\frac{3}{4}$ or 4·50lbs. of Irish L.L. 35's at 10·7d ,, ,, 48·2d
} 64·8d+20d=7/0$\frac{3}{4}$ per bdl.

Mix for 45's Lea Line Warp at 8s. 3d. per Bundle.

$\frac{1}{3}$ or 1·78lbs. of Irish L.L. 40's at 12·2d per lb. = 21·7d
$\frac{1}{3}$ or 1·78lbs. of Bruges L.L. 40's at 11·3d ,, ,, 20·1d
$\frac{1}{3}$ or 1·78lbs. of Dutch L.L. 40's at 10·6d ,, ,, 18·9d
} 60·7d+20d=6/8$\frac{3}{4}$ per bdl.

Mix for 50's Lea Line Warp at 7s. 9d. per Bundle.

$\frac{1}{3}$ or 1·60lbs. of Irish L.L. 45's at 13·8d per lb. = 22·1d
$\frac{1}{3}$ or 1·60lbs. of Irish L.L. 40's at 12·2d ,, ,, 19·5d
$\frac{1}{3}$ or 1·60lbs. of Bruges L.L. 45's at 12·6d ,, ,, 20·1d
} 61·7d+20d=6/9$\frac{3}{4}$ per bundle.

Mix for 55's Lea Line Warp at 7s. 6d. per Bundle.

$\frac{1}{2}$ or 2·18lbs. of Irish L.L. 45's at 13·8d per lb. = 30·1d
$\frac{1}{4}$ or 1·09lbs. of Bruges L.L. 50's at 14·0d ,, ,, 15·2d
$\frac{1}{4}$ or 1·09lbs. of Dutch L.L. 45's at 12·0d ,, ,, 13·1d
} 58·4d+20d=6/6$\frac{1}{2}$ per bdl.

Mix for 60's Lea Line Warp at 7s. 6d. per Bundle.

$\frac{1}{4}$ or 1·00lbs. of Bruges L.L. 50's at 14·0 per lb. = 14·0d
$\frac{1}{4}$ or 1·00lbs. of Dutch L.L. 50's at 13·2d ,, ,, 13·2d
$\frac{1}{4}$ or 1·00lbs. of Courtrai L.L. 50's at 18·3d ,, ,, 18·3d
$\frac{1}{4}$ or 1·00lbs. of Irish L.L. 50's at 15·3d ,, ,, 15·3d
} 60·8d+20d=6/8$\frac{3}{4}$ per bdl.

Mix for 65's Lea Line Warp at 7s. 9d. per Bundle.

$\frac{1}{2}$ or 1·84lbs. of Courtrai L.L. 50's at 18·3d per lb. = 33·7d
$\frac{1}{4}$ or 0·92lbs. of Bruges L.L. 55's at 15·4d ,, ,, 14·2d
$\frac{1}{4}$ or 0·93lbs. of Dutch L.L. 55's at 14·5d ,, ,, 13·5d
} 61·4d+20d=6/9$\frac{1}{2}$ per bundle.

Mix for 70's Lea Line Warp at 8s. per Bundle.

$\frac{1}{2}$ or 1·71lbs. of Courtrai L.L. 55's at 20·1d per lb. = 34·4d
$\frac{1}{4}$ or 0·86lbs. of Bruges L.L. 55's at 15·4d ,, ,, 13·2d
$\frac{1}{4}$ or 0·85lbs. of Dutch L.L. 55's at 14·5d ,, ,, 12·3d
} 59·9+20d=6/8 per bundle.

Mix for 75's Lea Line Warp at 8s. 3d. per Bundle.

$\frac{3}{4}$ or 2·40lbs. of Court L.L. 55's at 20·1d per lb. = 48·2d
$\frac{1}{4}$ or 0·80lbs. of Bruges L.L. 60's at 17·0d ,, ,, 13·6d
} 61·8d+20d=6/9$\frac{3}{4}$ per bdl.

Mix for 80's Lea Line Warp at 8s. 9d. per Bundle.

$\frac{2}{3}$ or 2·00lbs. of Court L.L. 60's at 21·9d per lb. = 43·8d
$\frac{1}{3}$ or 1·00lbs. of Court L.L. 65's at 23·8d. ,, ,, 23·8d
} 67·6d+20d=7/3$\frac{1}{2}$ per bdl.

Mix for 85's Lea Line Warp at 9s. per Bundle.

All or 2·82lbs. of Court L.L. 65's at 23·8d per lb. = 67·1d+20d=7/3 per bundle.

Mix for 90's Lea Line Warp at 9s. 3d. per Bundle.

½ or 1·33lbs. of Court C.L. 70's at 27d per lb. = 35·9d }
½ or 1·34lbs. of Court C.L. 75's at 29d ,, ,, 38·9d } 74·8d+20d=7/10¾ per bdl.

Mix for 100's Lea Line Warp at 9s. 9d. per Bundle.

⅔ or 1·6lbs. of Court C.L. 75's at 29d per lb. = 46·4d }
⅓ or 0·8lbs. of Court C.L. 80's at 31d ,; ,, 24·8d } 71·2d+20d=7/7¼ per bdl.

Mix for 110's Lea Line Warp at 10s. 9d. per Bundle.

½ or 1·09lbs. of Court C.L. 80's at 31d per lb. = 33·8d }
½ or 1·09lbs. of Court C.L. 85's at 33d ,, ,, 36·0d } 69·8d+20d=7/5¾ per bdl.

Mix for 120's Lea Line Warp at 11s. 6d. per Bundle.

All or 2·00lbs. of Court C.L. 85's at 33d per lb. = 66·0d+20d=7/2 per bdl.

Mix for 130's Lea Line Warp at 12s. per Bundle.

All or 1·84lbs of Court C.L. 90's at 36d per lb. = 66·2d+20d=7/2¼ per bdl.

Cut Line. Lot Ticket.

Although these mixes show immense profit in the yarns composed of Courtrai cut line (middles), and although, as previously remarked, the profits are much the greatest in the very fine end; yet the valuation assigned to "cut line sorts," although proportionately correct, is rather misleading for this reason : —All the coarser sorts, from 70's down, in the cut line ticket, are only the ends, which are not even nearly proportionately as valuable as the middles; these ends, from their unevenness and impurity, being suitable only for the medium range of light warp and weft yarns. Therefore the 50's, 55's, 60's, and 65's of the cut line ticket are worth only about 11d., 12d., 13½d., and 15d. per lb., where the 70's, 75's, 80's, and 85's are worth about 32d., 36d., 42d., and 48d. per lb.

Lot Ticket Miscalculations.

Before we leave this subject of flax calculations, it may be advisable to remark on a few matters of importance in connection with it. Small yield makes a dear dressed lb. Tow valued at one penny per lb. too cheap, increases the cost of a lb. of dressed line about ½d. ; making no allowance for either the tow or the dressing, but setting one against the other, increases the cost of dressed line about 2d. per lb. The cost of dressing taken 1s. per cwt. too dear, increases the cost of a dressed lb. about ¼d. and *vice versa* in each instance.

The manager should keep a few pages of his pocket book headed off as shown below, and on the lot being finished and added up in the "lot book," he should transfer from it the particulars specified, into his note book. This list will be useful for reference and comparison and as a guide when he is calculating the cost of a new mix.

FLAX NOTES.

Flax Note Book.

Lot.	Market.	Cwts.	At per Cwt.	Yield per Cwt.	At per lb. Dressed	Average Lea.	Constant No.	Range of Sorts.	Finished Hackling.

Arrangement of Flax Department

The arrangement of the "Flax Department" on the most approved principles must be regulated according to circumstances. If the establishment be small, say one of only 5,000 to 10,000 spindles, it may be advisable to have the "roughing," "machines," and "sorting" all on the same flat, and under the eye of one overlooker. If it be extensive, say from 20,000 to 30,000 spindles, the roughers should be located separately, under a roughing master, who will be responsible for his own department. Care should be taken to have this shop close to the machine room, and as near to the rough flax store as possible.

The sorting shop should be distinct from the two above-mentioned departments, and under the charge of a sorting master. It should be as near to the machine room, the dressed line store, and the tow store as can be arranged. But if these shops must of necessity be distant from one another, communication can generally be rendered easy between them by means of hoist, shoot, or trap-door.

Good light and ventilation in all three places may be looked upon as indispensable, more especially in the sorting shop. This should also be protected from the sun's rays by white blinds; yellow blinds are to be avoided, as the peculiar shade they give deceives the sorter in the appearance of his flax, and confuses him when judging it. Gas light has the same injurious effect, especially upon the finer cream-coloured classes; in fact, it may be considered impossible for any man to sort cut line correctly by gaslight. Men on this class of work should be permitted to work only during daylight.

Overseers' Wages.

Where the shops are distinct from one another, the following may be considered a fair guide as to what wages the overlookers should receive. Roughing master, rougher's pay and 3d. per man on all in his shop making full time; machine master, roughers' pay, or 4s. per machine; sorting master, sorter's pay and 2½d. per man on all his shop making full time; all per week.

This arrangement, besides tending to the introduction of steady hands, would be likely to improve the style of work turned out, as the men would not be permitted to do more than they could do properly. Sorter's standard rate of wages has been as follows:

Hacklers' Wages.

All classes; made work.		1855.	1865.	1875.	1884.
Long line, broken, 60 to 100 lbs.	per day	2/9	3/6	4/2	3/9
Long line, unbroken, 90 to 160 ,,					
Cut line, long, 40 to 70 ,,					
Cut line, short, 10 to 40 ,,					

Hand-hackle Tools.

We will conclude our remarks on the flax department by referring to the hackles, more commonly called tools, requisite for all classes of work. The difference of opinion which exists on many points connected with the hackles is a sufficient proof of the necessity for giving the subject some consideration. It is evident that if the pins be set too sparsely the tool will not do its work; if too much crowded there will be an unnecessary tow made; and if the pins be either too short or too long, there will be the same results. The writer gives, therefore, a table in which all these items have received full consideration.

	Ruffers and 1st Hand.			2nd Hand.			Sorter's "ten,"						3rd Hand.		
Tool	—	—	—	—	—	—	10	12	14	16	18	20	25	30	35
Pins per square inch	2	3	4	6	9	12	15	20	25	30	35	40	50	55	60
Wire gauge No	4	5	6	8	9	10	11	12	13	14	14	15	15	15	16
Length over all	in. 7¼	in. 7¼	in. 7¼	in. 6¼	in. 6¼	in. 6¼	in. 4¼	in. 4¼	in. 4¼	in. 4¼	in. 4¼	in. 3¾	in. 3¾	in. 3¾	in. 3¾

	3rd. Hand.		4th Hand.									
Tool	40	45	50	60	70	80	90	100	110	120	130	140
Pins per square inch	65	70	75	80	90	100	110	120	130	140	150	160
Wire gauge No	16	16	17	17	17	18	18	18	19	19	20	20
Length over all	3¾in.	3¾in.	3¼in.	3¼in.	3¼in.	2¼in.	2¼in.	2¼in.	2in.	2in.	2in.	2in.

5th Hand and Sorter's "Switch."

150	160	180	200	210	220	230	240	250	260	270	280	290	300
180	200	220	240	260	280	300	320	340	360	380	400	420	440
21	21	22	22	23	23	24	24	25	25	26	26	27	27
2in.	2in.	2in.	2in.	$1\frac{3}{4}$in.	$1\frac{3}{4}$in.	$1\frac{3}{4}$in.	$1\frac{3}{4}$in.	$1\frac{3}{4}$in.	$1\frac{3}{4}$in.	$1\frac{3}{4}$in.	$1\frac{3}{4}$in.	$1\frac{3}{4}$in.	$1\frac{3}{4}$in.

The stocks of all tools, except the ruffer, and 1st and 2nd hand, are supposed to be one standard length, viz., $7\frac{1}{4}$in. ; and from 2in. to 3in. broad. The column under heading of "tool" is derived from the number of pins in a row of this length, and thus are the tools classed. For example, a 40 tool has 40 pins to the $7\frac{1}{4}$in., a 200 tool has 200 pins to the same length, etc., etc. The ruffers and 1st and 2nd hand are generally about 9in. long by 4in. broad.

PART II.

LINE PREPARING DEPARTMENT.

CHAPTER VI.

FLAX PREPARING.

THE preparing or fourth process which flax undergoes in the spinning mill next claims our attention.

The fourth Process. Its Importance.

The importance of care and order, combined with practical knowledge in this department, cannot be over-estimated. Here, in fact, is the success of flax spinning "made or marred." It matters not how carefully the fibre is brought forward in the flax department; if it be not properly treated in the preparing process all the care previously bestowed upon it may be of no avail.

Old *v.* new Machinery.

On the other hand, if the machinery in the preparing room be thoroughly adapted to its work, it is surprising how excellent a foundation can be laid for the production of a sound level yarn, even out of very inferior material. The best fibre, thoroughly hackled, will be "murdered" in the preparing department if it is not treated properly, as, for instance, if it get not sufficient "doublings," and be produced light enough at the "spread-board."

Conversion into Sliver.

This is the first machine through which the fibre is passed in the preparing process, and it is here converted into "sliver." The sliver may be described as one continuous riband of pure dressed line, of indefinite length, and from one to five inches in breadth. It is perfectly level, of smooth, glossy appearance; the fibres lying in juxtaposition, with their ends interwoven and overlapped, so as to give no evidence to a casual observer of their ever having been separate and distinct.

Spreading.

The principal method of putting in sufficient doublings at the spread board is for the girl attending it (called a "spreader,") to piece-out the flax pieces, as they are lifted off the sorter's bunch, into as many portions as are consistent with neat and accurate separation, without tossing the fibre, and then to lay these pieces evenly one over the other, top end foremost, and extending down the revolving table or "leathers" of the spread board, in an even straight line. Besides lying on each other, each piece must fall a little behind its predecessor, and it is to allow this overlap to be as close and as regular as possible, that the pieces have to be separated into many portions. Another reason for the "small piecing out" is, that the close spreading may not produce too heavy and thick a sliver at the front of the spread board, when the latter is kept on a fairly short "draft." Too heavy sliver would detract from the good results derived from small piecing out, as so many less "slivers" or cans, would have to be passed together over the succeeding machine, called the first drawing or "set frame," where plenty of doubling is quite as essential as it is on the spread-board. In Preparing, the aim should be to get in the "doublings," whilst the process is still in its infancy, heavy spreading, and consequently few slivers over the "set frame" giving poor results; even though an effort be afterwards made to counteract this evil, by an unusual amount of doubling over the finer "drawings" and "roving frame." The reason for this is that if unevenness and thick parts be once introduced into the sliver, even the thousands of doublings it will subsequently receive will not completely

Time for Doubling.

obliterate these defects. Whereas, if the sliver be once formed without these faults, no after process can introduce them, unless by the grossest carelessness. The after process in preparing consists in drawing out, or as it is called, "drafting" the sliver to the requisite fineness of body, over drawing frames; the doubling being introduced for the purpose of keeping up or improving its levelness. Some persons hold that the doubling has another object, namely, to keep up a sufficient body of sliver to be again and again drafted, and hackled at the same time, by being drawn through the "gills."

Gill Hackling.

But, in the writer's opinion, if the fibre be properly treated in the flax department, there is no necessity for this; in fact, it is injurious, breaking up and softening the fibre, so as to deteriorate the quality itself, and injuriously affect the preparation.

Drafting.

The drafting above referred to is carried out by means of two sets of rollers, one set before and one behind the sheet of fallers or "gills." The front set, called the boss and pressing rollers, grip the fibre as if in a vice, at their point of contact called the "nip," and draw it rapidly from the gills. The back set called the "feed and jockey rollers," deliver the fibre into the gills, preventing more than a stated regular supply passing in, and consequently, being drawn out.

Draft Calculations.

The difference in length between that drawn out, and that given in, is called the "draft." The length of draft is regulated by toothed wheels called "gearing," and all calculations connected therewith can be made out in one of three ways, either mechanically, practically, or theoretically.

Drafting mechanically is to commence at the first or motive power, and by multiplying the revolutions of this first power, by the diameters or number of teeth (the pitch being similar) in those wheels which communicate this power, and which are commonly called "drivers, pinions, or leaders," and dividing the result thus arrived at by the diameter or number of teeth in those wheels which receive the power, and which are called "drivens, wheels, or followers;" getting as result the revolutions of the different portions of the machine, in proportion to that of the first or motive power.

Drafting by practice, or "rule of thumb," is arriving at a conclusion by actual measurement, so much in, so much out, which is the most satisfactory plan to those whose ignorance leads them to doubt the accuracy of the other method of calculation; but it is not so accurate. Drafting by theory is to make use of those wheels only, in the calculation, which directly affect the "draft," without any regard to in-take or out-put. These are wheels, the alteration of any of which will affect either the feed or delivery separately; all wheels common to both not affecting the "draft," and therefore not requisite in the calculation. This method is the most speedy.

Intermediate Gearing.

All wheels running slack on studs, but acting as connecting links in the train of gearing, in no way affect either speed or draft. These are what are called "intermediates," and are to be entirely overlooked so long as they are themselves the communicators. But, if over the elongated "pap" of one or more of these intermediates there be screwed or keyed another wheel which is in connection with some other train of gearing, then must this intermediate be taken into consideration, as it becomes a "follower" to this latter train.

Stud Gearing.

This will be understood by observing that the wheel on the pap of the intermediate, and which becomes a leader, has for primary motion the speed at which the intermediate, to which it is keyed, revolves. This makes the introduction of these two wheels into the calculation, all important; they may now be called "stud follower" and "socket leader."

Therefore all wheels transmitting motion, but running slack and unfettered on their studs, are of no account in any calculation. But all wheels keyed or screwed to any part giving motion to any other part, are of vital importance in speed calculations. When speaking of wheels of the former type, we will designate them as passive, those of the latter type being active.

Gearing Summary.

Calculating by Theory.

The explanation of the theoretical method will be better understood by the reader noticing the relation that the delivery and feed wheels have to one another; though they be both "followers" in relation to the speed or socket leader. The larger the boss roller wheel, the shorter will be the draft; whilst the larger the the feed roller wheel, the longer it will be. Therefore, the values of these two wheels, when taken in relation to the draft, are diametrically opposed to each other.

This fact makes it necessary, in the theoretical method of performing the draft calculation, to reverse their relative positions. In the mechanical calculation the delivery quantities are divided by those of the feed; inversely, in the theoretical calculation the feed quantities must be divided by those of the delivery. Therefore, to save time, the positions of all active gearing in connection with the delivery are reversed; that is, followers (if any) are placed as divisors, and leaders (if any) and roller diameter, as dividends. The active gearing and roller diameter in connection with the feed, retain their customary position.

Spread-board Calculations.

We will illustrate the different methods of calculating the draft of a machine, spread-board; according to their order :—

Drafting Mechanically.

	130	Revolutions of driving shaft.	
	12	Inch drum.	
Pulley, inches	20)1560		
	78	Revolutions of bottom shaft.	
	30	Speed wheel.	
Boss-roller wheel	60)2340		
	39	Revolutions of boss-roller diameter	2·75 inches
	37	Boss pinion	39 revls'
Back shaft (change) wheel	54)1443		107·25*
	26·72	Revolutions of back shaft.	
	13	Back shaft pinion.	
Stud wheel	110·°°)347·36		
	3·16		
	19	Socket pinion	
Feed wheel	42·°°)60·04		
	1·43	Revolutions of feed roller; dia' 2·50 inches.	
	2·50	= diameter.	
	3·57)107·25*		
	30·04	Draft on machine.	

Drafting by Rule of Thumb.

Revolutions of feed roller	1·43	39·00	Revolutions of boss-roller.
Circumference do. inches,	7·85	8·64	Inches circumference do.
In, inches	11.22	336·96	Inches, out.
		30·04	Draft.

Drafting Theoretically.

$$\frac{\text{Boss-roller pinion} \ldots\ldots \ 37\cdot}{\text{Bose-roller diameter} \ldots\ldots \ 2\cdot75} = 13\cdot45$$

$$\frac{54 \times 110 \times 42}{\qquad \times 13 \times 19 \times 2\cdot5} = 404\cdot02$$

NAMES OF WHEELS.

$$\frac{\text{Back shaft (draft change) wheel} \times \text{stud wheel} \times \text{feed roller wheel.}}{\qquad \times \text{back shaft pinion} \times \text{socket pinion} \times \text{feed roller diameter}}$$

$$\frac{\text{Feed quantity} = 404\cdot02}{\text{Delivery quantity} = 13\cdot45} = 30\cdot04 \text{ Draft.}$$

Or, (speedy)—

$$\frac{54 \times 110 \times 42 \times 2\cdot75}{37 \times 13 \times 19 \times 2\cdot50} = 30\cdot04$$

NAMES OF WHEELS.

$$\frac{\text{Back shaft (draft change) wheel} \times \text{stud wheel} \times \text{feed roller wheel} \times \text{boss roller diameter}}{\text{Boss roller pinion} \times \text{back shaft pinion} \times \text{socket pinion} \times \text{feed roller diameter.}}$$

Drawing-frame Calculations.

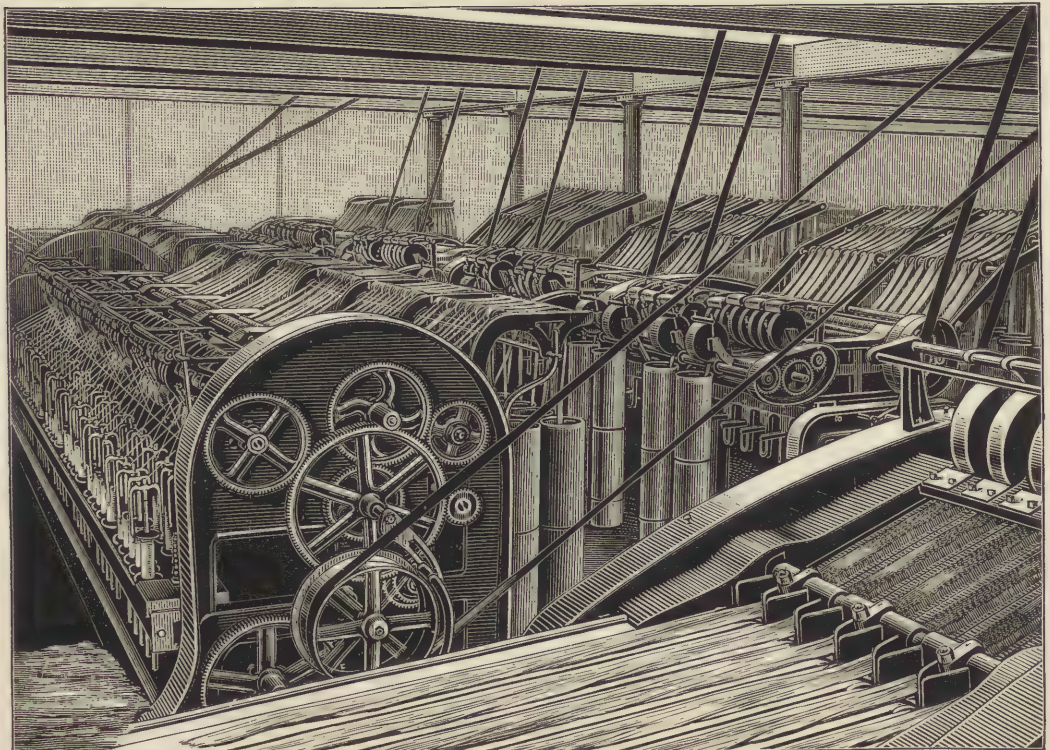
We will also illustrate the different methods again, in the drafting of a drawing frame, the arrangement of the gearing on this differing slightly from that of the spread-board.

Drafting Mechanically.

	130	Revolutions of driving shaft.
	12	Inch drum.
Pulley, inches	16)1560	
	97·5	Revolutions of bottom shaft.
	28	Speed wheel.
Boss-roller wheel	63)2730*	
	43·33	Revolutions of boss-roller; dia' 2·25 inches. 43·33 / 97·49
Stud follower	120)2730*	
	22·75	
	87	Stud leader.
Back shaft (change) wheel..	72·°)1979·25	
	27·49	Revolutions of back shaft,
	20	Back shaft pinion.
Stud follower	60·°)549·80	
	9·16	
	20	Stud leader.
Feed wheel	60·°)183·20	
	3·05	Revolutions of feed. Diameter 2 inches.
	2	
	6·10)97·49	
	15·98	Draft.

Drafting by Rule of Thumb.

Revolutions of feed roller..........	3·05	43·33	Revolutions of boss-roller.
Circumference........................	6·28	7·07	Circumference.
Inches in	19·15	306·34	Inches out.
		15·98	Draft.



A "LINE" SYSTEM.

Drafting Theoretically.

$$\frac{\text{Boss-roller wheel} \ldots\ldots 63}{\text{Boss-roller diameter} \ldots\ldots 2{\cdot}25} = {\cdot}28.$$

$$\frac{120 \times 72 \times 60 \times 60}{- \times 87 \times 20 \times 20 \times 2} = 446{\cdot}89$$

$$\frac{\text{Stud follower} \times \text{back shaft wheel} \times \text{stud follower} \times \text{feed roller wheel}}{- \times \text{stud leader} \times \text{back shaft pinion} \times \text{stud leader} \times \text{feed roller diameter.}}$$

$$\frac{\text{Feed quantity} \ldots = 446{\cdot}89}{\text{Delivery quantity} = 28{\cdot}00} = 15{\cdot}96 \text{ Draft.}$$

Or, (Speedy)—

$$\frac{120 \times 72 \times 60 \times 60 \times 2{\cdot}25}{63 \times 87 \times 20 \times 20 \times 2{\cdot}00} = 15{\cdot}96 \text{ Draft.}$$

$$\frac{\text{Stud follower} \times \text{back shaft wheel} \times \text{stud follower} \times \text{feed roller wheel} \times \text{boss roller diam.}}{\text{Boss roller wheel} \times \text{stud leader} \times \text{back shaft pinion} \times \text{stud leader} \times \text{feed roller diameter.}}$$

Reference has been made to "doubling," that is, the number of slivers that are doubled together during the drafting process, and delivered in the form of a single sliver.

As before remarked, this doubling is to keep up sufficient "body" of sliver to permit of its being "drafted and doubled" to such an extent as may tend most to the production of an open and perfectly level sliver.

Graduation of Doublings.

If the number of doublings, *i.e.*, slivers, exceed the units of draft on any frame, it is obvious that a heavier sliver will be produced off this frame than any of the slivers passing through it, that is, than the sliver from the front of the preceding frame. Except in the case of spread-board sliver, this should be as far as possible avoided; as the frames are graduated, each being finer than its predecessor, consequently so should the material passing over become lighter.

A System.

The gradation of frames in preparing is named a "system," a certain number of machines specially adapted to each other, and for the particular class of material for which they are set apart. A system may consist of one or two spread boards; two to four drawing frames; and one roving frame; each regulated to supply the succeeding one.

The general allotment to a preparing system is one spread board; one set frame; one second drawing; one third drawing; and one roving frame. It is only where the preparation is unusually coarse, or exceedingly fine, or where there may be a pinch for space, that this arrangement is departed from.

The amount of "doubling" depends entirely upon circumstances, and varies from one thousand to one hundred thousand over a system. Doubling implies expense in preparing, therefore the coarse and poorer numbers are allowed as few doublings as possible, slight irregularity in the "levelness" of the sliver not showing in coarse numbers as in fine. But doublings are absolutely necessary in the finer and better numbers, though not necessarily to such great extent as in the higher limit above given.

Proportion of Doublings.

The reason doubling sometimes reaches the high figure of "one hundred thousand" is that in the very finest preparing, say from 200's to 400's lea, it is advisable to have the least possible stress laid upon the gossamer sliver as it is drawn from the gills and over the doubling plate; this being effected by fewer rows of gills to each delivery.

As doublings are essential, in such a case it is imperative to give the sliver a fourth drawing, to put in doublings otherwise lost by the curtail-

ment of the doubling power of each machine individually. This fourth drawing increases the doublings in such a ratio as to bring the total well up to the "hundred thousand." The following table will illustrate the average doublings over different classes of system :—

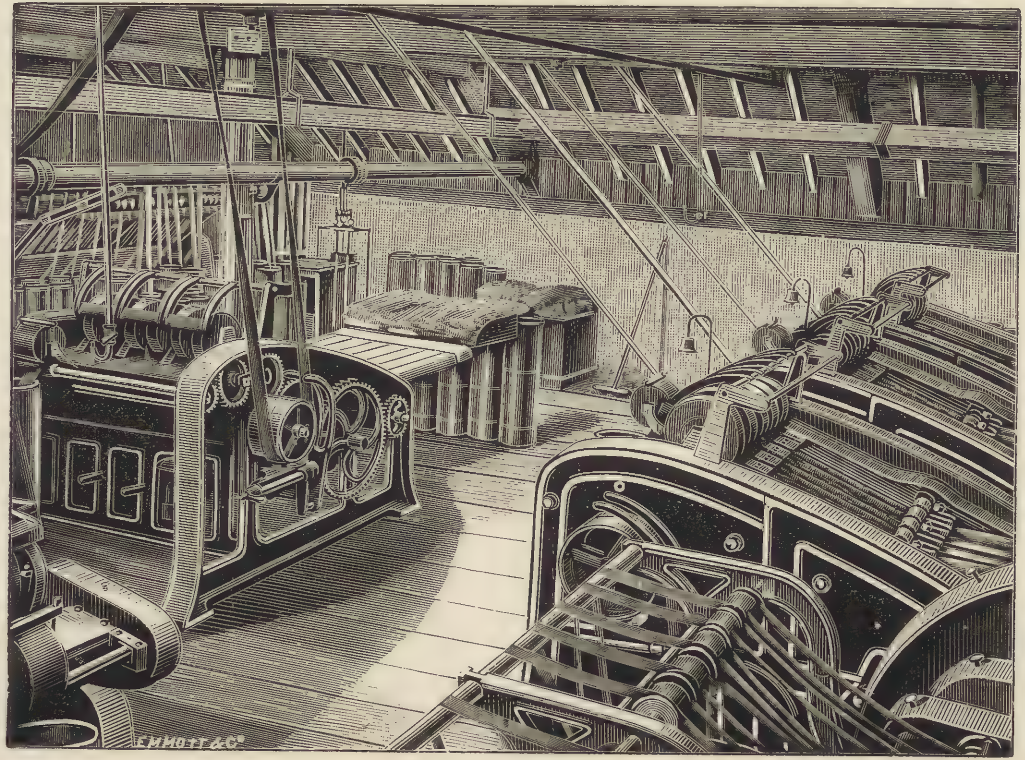
MACHINE.	Slivers per Delivery.		Doublings.	Slivers per Delivery.		Doublings.	Slivers per Delivery,		Doublings.	Slivers per Delivery.		Doublings.
Spread Board	4	=	4	6	=	6	8	=	8	6	=	6
Set Frame..............	6	,,	24	16	,,	96	24	,,	192	12	,,	72
2nd Drawing	12	,,	288	16	,,	1,536	16	,,	2,872	12	,,	864
3rd Drawing............	4	,,	1,152	8	,,	12,288	12	,,	34,464	12	,,	10,368
4th Drawing............		..			..			..		8	,,	82,944
Roving Frame..........	1	,,	1,152	1	,,	12,288	1	,,	34,464	1	,,	82,944

Arrangement of machinery.

Preparing machinery should be so arranged that there may be the shortest possible distance to carry the sliver in cans, from the front of one frame to the back of the succeeding. This has the threefold advantage of permitting the girl attending to mind the maximum number of frames, consistently with thorough supervision; to reduce the chances of mixed slivers; and to lessen the wear and tear upon sliver-cans and floor.

Of course, the appearance and general order of the room must not be sacrificed to these objects. For instance, the spread boards should be in a row or rows, as also should be the drawing frames, and roving frames; the fronts of each being in a straight line, with passages between these rows.

In arranging the spread boards there should be ample room left behind them for the reception of baskets containing the "dressed line" from the store.



SPREAD BOARDS.

CHAPTER VII.

THE SPREAD BOARD.

THE spread boards should be supplied daily with dressed line from the store, as it is not advisable to keep too large a stock of dressed line in the preparing room. There should be strong and well lined large "skips," into which the line bunches should be carefully laid in the store, as they are required for the preparing process, and not again taken out or disturbed until they are placed on the spreader's table. This system lessens the chance of mixture by mistake, there being only one sort put into each skip; and the great injury done to dressed line by too much handling is avoided.

Material.

The skips containing the bunches should be ranged behind or near to the particular spread boards for which the sort of flax they contain is needed; or if space cannot be allotted for this arrangement the line might be lifted out of the baskets, and placed in "cells" built for its reception.

In many cases it may appear impossible to transport the material from the store to the preparing room without handling it, but the buildings must be very crooked indeed where this can not be accomplished with the aid of one or more "hoists," which are no doubt costly to get up, but so convenient and labour-saving as soon to repay the outlay; leaving entirely out of consideration the inestimable advantage of receiving the fibre into the preparing room unruffled, and with ends free from "matting."

Flax Loosing.

In a room of average size there will be ample work for one girl loosing the bands off the bunches as they are required, straightening up the outside pieces, if they happen to have been tossed, and then laying the bunch in the proper place at the table.

Mixing of Fibre.

It is often advantageous to mix different classes and sorts of dressed line, and this is generally performed at the spread board by so many "leathers" being devoted to each variety. The nature and proportions of this mix are copied by the preparing master off the list he receives, upon a slate or board set up behind each frame. The "flax looser" is responsible for laying down the kinds and proportions of flax here specified, and seeing that the "spreader" uses the correct quantity of each. The spreading of the mix is performed as before explained.

Structure of Machine.

The construction and shape of a spread board is as follows:— It is a machine of about ten feet in length from front to rear, by about four or five feet wide and high. A plain roller of steel, or malleable or cast iron, of any diameter from two to four inches, is placed parallel to the floor, and about three and a half feet from it, resting upon two bearings—one for each end—cast in the two gables or frames, upon which the structure of the machine is reared. These bearings are fitted with brass seats, in which the "necks" or journals rest. Of course this roller, which is the "boss roller," is at right angles to the gables. In front of this roller there is placed, also resting upon the

gable, a cast-iron plate, called the "doubling plate." In this plate are cast diagonal holes or slits, through which the "sliver" is drawn as it comes from the gills to be doubled. The number of slits in the doubling plate depends upon the number of rows of gills in the head of fallers. The faller is a bar of iron to which the gills are rivetted, and so carried forward, as these fallers—there being many in a head —rest on "slides," their ends being retained in the threads of "spiral screws" revolving beside the slides. The slides project close up to the boss roller on each side, and thus the fallers are carried up to the boss roller by the screw; only sufficient space intervening between the ends of the slides and the surface of the boss roller for the faller to be knocked down off the top slide to a bottom one, along which it is carried back by another revolving screw of coarser pitch, to leave room for the faller following to take the same course. When the faller comes to the lower end of the bottom slides there are tappets that come in contact with it, and raise it on to the upper slides to go over the same ground again, indefinitely. There is a faller for every pitch or thread of both bottom and top screws, so that their appearance, when in position, is that of an endless sheet of iron rods covered with bristling rows of steel pins.

Doubling Plate.

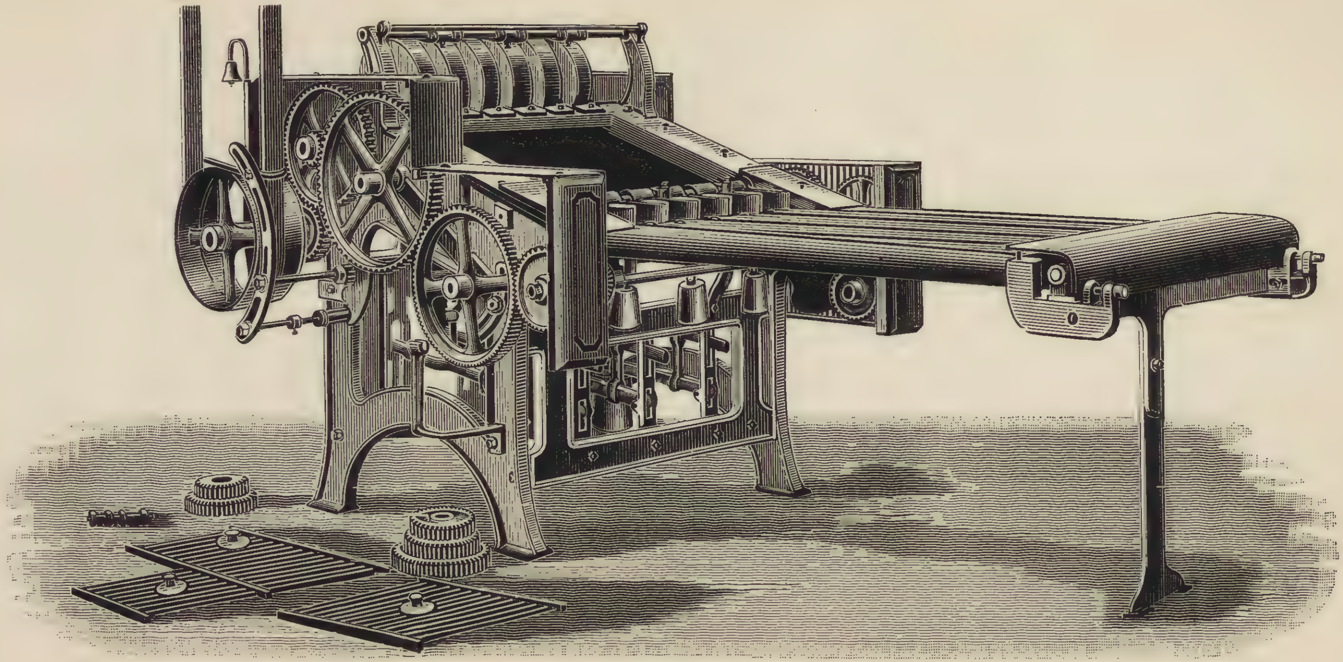
Faller.

Remark was made of a back or feed roller. This roller faces close up behind the ends of the screws and slides, on a level with the top of the fallers, and parallel to them, and consequently to the boss roller as well. Behind this feed roller, there is a conductor plate, which is a plate with iron or brass conductors screwed on to it directly behind the rows of gills. Thus anything passing through these back conductors must pass over the feed roller into the rows of gills in the head of the machine. Covering and enclosing these gills at the front of the spread board, and just over the boss roller, is a conductor bar. This is an iron bar with brass conductors a little narrower than the gills depending from it, and around the back of, and up to the top side, of the boss roller. Anything delivered from the gills passes through these conductors and on to the boss roller in a narrower form than it was given into the gills. The object of this will be explained further on. Working in stands or "yews," which are connected either to the conductor bar or to the doubling plate, are pressing rollers, which rest upon the upper side of the boss roller. These pressing rollers are the means by which the flax is drawn from the gills in the form of sliver. They are formed of round bosses of wood made the breadth of the gill at least, so as to cover the front conductor on both sides. These bosses are pressed on to an axle or "arbour" in pairs, the bosses being the same distance apart as the spaces between the gills on the faller. For example, where there are six gills per head it requires three separate arbours with two bosses on each, to cover the upper surface of the boss roller. These rollers are set in the "yews" at the most appropriate angle to the "nip" or point of contact with boss roller. The slot in the "yews" to produce this desired position of pressing roller may be taken as most suitable when at right angles to the face of doubling plate. The reason for this is that with this arrangement the maximum size of the pressing roller can be admitted without throwing it so much forward on the boss roller as to become a sort of wedge on itself, which would retard its "drawing" capacity, or otherwise so far back as to come in contact with the brass conductor. Arrangements for the admission of the largest pressing rollers can be facilitated by the sheet of fallers being on a decline from the boss roller to the feed roller, as this admits of the brass conductor sloping more away from contact with the sur-

Feed Roller.

Front Conductors.

Pressing Rollers.



SPREAD BOARD (Back View).

face of the pressing roller. But this decline of the fallers is not usual unless in the case of spread boards, nor indeed is a large pressing roller of so much moment in either drawing or roving frame, as in the spread board.

The Hanger. Between the bosses of these pressing rollers is attached to the arbour what is called a "hanger." This hanger catches over the arbour by a hook with a brass seat in it, and into the other extremity of this hanger is hooked the spring-wire. On the lower end of this spring-wire is a screw which passes through a slot in the end of a lever connected to the frame work of the machine.

Leverage. By placing a thumbscrew on the end of the spring-wire and screwing it up against the lever, the whole weight concentrated at this point is communicated to the pressing roller through the medium of spring-wire and hanger. Behind the feed rollers is an endless revolving sheet of leather going at the same surface speed as that of the feed rollers. The fallers also go at the same pace, or a little faster, to give them what is called a lead. This "lead of faller" is necessary to cause the fibre to bed properly into the pins, or in common parlance, "to pin properly." The flax, after being spread, is delivered by these revolving sheets into the back conductors, and through them into the gills, from between the feed rollers.

Gills. The fibre lies in the gills until the longer and foremost portions are drawn quickly away by the boss and pressing rollers, which revolve at much greater speed than the feed rollers. Thus are the fibres drawn parallel and rapidly from the pins as the fallers advance, and so are delivered in a continuous light and level sliver on to the doubling plate, down through the diagonal slits, travelling overlapped together under the plate, and up through the farthest slot, here to meet the outside sliver, which does not pass through the doubling plate, but amalgamates with the others, all being delivered through the delivery rollers in one compact, level, and strong sliver. The sliver, as thus delivered from the spread board, is passed into cylindrical cans placed to receive it, after each yard so delivered is measured and registered by a simple arrangement, which may be thus explained.

Sliver Measurement. There is a small "worm" wheel on the extremity of the delivery roller referred to. This worm is in gear with a small wheel on a stud called a "socket wheel." On the elongated "pap" of this socket wheel is another worm which is in gear with a wheel called the "bell wheel." Each revolution made by this bell wheel causes a pin, protruding from its side, to force back an upright steel rod or spring, on the top of which is fixed a bell. At a certain position the slowly revolving pin ceases to come in contact with the bell rod, this permitting the latter to rebound, loudly ringing the bell.

The Bell. This indicates a certain fixed length of sliver to have been now delivered into the can, which is now considered full, and replaced by an empty one, to be in its turn filled. The intervals at which the bell will ring can be altered, by change of wheel, to deliver any required length of sliver, say from 300 to 2,000 yards.

Length of Bell Calculation. As the worm wheels on the end of the delivery roller and pap only shift the wheels into which they are geared one tooth for each revolution of the part to which they are attached (unless the worms be double or treble threaded, when their power will be in the same ratio), it follows that the natural and short method of calculating the length of the bell is to multiply the circumference of the delivery roller boss, in inches, by the number of teeth in the socket wheel, and the result by the number of teeth in the bell wheel; the total being divided by the inches in a yard will give the yards in bell; thus:—

```
                        9·42 cir. of delivery roller boss, in inches.
                          37 teeth in socket wheel.
                      ------
                      348·54
                         103 teeth in bell wheel.
                      ------
Inches in yard 36)35899·62
                      ------
                         997 yards per one revolution of bell wheel.
```

The measurement of the sliver off the spread boards is rendered necessary from the fact, that, in the preparing, it is essential to be able to produce the sliver of any required number of yards per pound weight. A certain number of these measured cans are weighed, the nett total being termed the weight of the "set." As all cans in a set are to be doubled into one sliver, there are virtually only so many yards in length to this weight of set as there are yards in the bell. This point being understood, it is only a question of calculation to find out how many yards per pound or ounce, of 16 drams, the length of the sliver will be increased during the succeeding draftings and doublings. The shorter the drafts and the greater the doublings, the lighter will the "set" require to be to produce a given number of yards; and the longer the drafts and the less the doubling, the heavier will it require to be to produce the same number of yards.

The Set.

For fine and special preparation light sets are absolutely necessary, as more than a certain number of cans cannot be put into the set, as there would not be room to place too many under the sliver pullies of the back rails of the frame; and even if there were, with too many slivers passing into each back conductor of the "head," they would ride in on one another; or, as it is termed, "lurk." This lurking of the sliver produces "thicks and thins" as the fibre is drawn from the pins, and, it need scarcely be remarked, is excessively injurious to the preparation. Consequently, in no instance it can be pronounced to be advantageous to have more than two slivers over each gill, and as light spreading is essential to excellence, as before explained, so must the weight of the "set," over fine systems, of necessity be light. In illustration :—

Cans in Set.

Set Calculations.

```
                                  100 yards per ounce (16 drams), rove.
                                   16 ounces.
                                -----
      Roving frame draft = 16)1600 yards per lb., rove.
                                -----
                                  100 yards of sliver per lb., off 3rd drawing.
                                    8 doublings per 3rd drawing sliver.
                                -----
       3rd drawing draft = 15)800
                                53·33 yards off sliver per lb., off 2nd drawing.
                                   12 doublings per 2nd drawing sliver
                                -----
  2nd drawing draft = 16·00)639·96
                                -----
                                   40 yards of sliver per lb. off first drawing.
                                   12 doublings per 1st drawing sliver; or cans in set.
                                -----
       1st drawing draft = 17)480
                                -----
                             28·25)yards of sliver per lb. off spread board.
                                  )800·00 yards in bell
                                   -------
                                    28·32 lb. per can.
                                       12 cans in set.
                                   -------
                                      340 lb. in set.
```

100 yards per ounce (16 drams), rove.
16 ounces.
———
Roving frame draft = 12) 1600 yards per lb. rove.
———
133·33 yards of sliver per lb. off 3rd drawing.
8 doublings per 3rd drawing sliver.
———
3rd drawing draft = 12.°°)1066·64
———
88·89 yards of sliver per lb. off 2nd drawing.
12 doublings per 2nd drawing sliver.
———
2nd drawing draft = 13.°°)1066·64
———
82 yards of sliver per lb. off 1st drawing.
12 doublings per 1st drawing sliver ; or cans in set.
———
1st drawing draft = 14)984
———
70·21)yards of sliver per lb. off spread board
)800·00 yards in bell.
———
11·39 lbs. per can.
12 cans in set.
———
137 lbs in set.

Skill in Spreading.

If over 28 pounds weight per can of 800 yards be not too heavy spreading for coarse numbers, it may, at first sight, seem impossible to spread so lightly and evenly as that the same length can be drawn out of 11 pounds ; but so delicate do the spreaders become in their sense of touch, and so accurate in the piecing and spreading of the flax, that they can produce these cans to within two ounces of any desired weight, even for weeks at a time ; and their judgment becomes so nice, that in many instances they can produce cans weighing within an ounce or two of any required weight, even if this be some pounds over or under the usual average weight. The limit to which delicate spreading can be brought—with skilled hands—may be said to depend on the proportioning and degree of fineness of the gills, conductors, etc., of the machine. We have heard of 4½lb. of dressed line being spread over a 2,000 yards bell.

Dial and Clock.

Among exceptionally coarse work, and in some of the more backward and old-fashioned establishments, the spreader's sense of touch is not entirely relied upon, a mechanical arrangement in the form of a dial clock and spring balance being introduced for her guidance. According to the weight of sliver desired, this dial can be regulated, and the pointers on this dial and on the spring balance being then kept to the same figures or signs, as the flax is laid upon the leathers, so will the sliver produced be of one uniform weight. Such is the uniformity attained in this way that generally with this system there is no necessity for bells, nor in consequence, for the making up of sets.

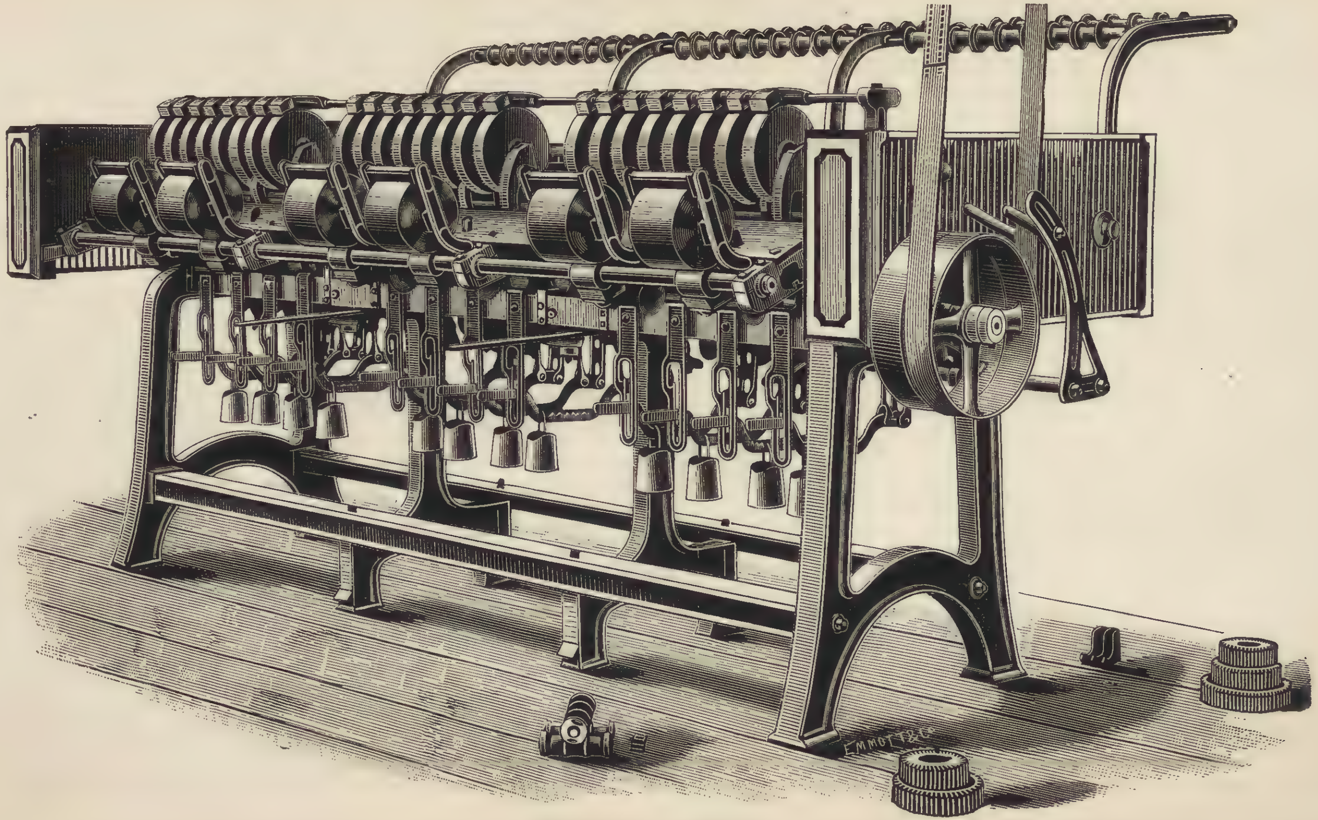
Mechanical Spreading.

But in time the girls become careless, and only look to the pointers as someone in authority may happen to be coming in their direction. If they find they have been spreading too heavily or too lightly they immediately go into the opposite extreme to counterbalance the excess or deficiency, and the evil results require no comment. This system may be very useful for beginners, as they have not learned to depend upon their touch, but in no other case should it be adopted. Another method of trying to secure an undoubtedly level sliver off the spread board is to space off the leathers at intervals of from three to six inches, according to the class of machine, with painted stripes, the spreader being instructed to lay the top of each piece to

these lines. The mistaken judgment of this arrangement is also patent, as if the pieces be not all of one thickness such accuracy of laying on is worse than useless.

Intellectual Spreading

Let the spreaders be instructed to spread the flax as level as possible, without regard to the weight the can should be, as this can all be regulated in the making up of the set. If the "set boy" requires cans heavy or light he must not so advise the spreader in the middle of a bell, but must wait until the passing through of the flax on the leathers, and the set bell rings. At this juncture the boy states the weight the next can is required to be, when, in nine cases out of ten, an average spreader will come near to the weight required.



DRAWING FRAME.

CHAPTER VIII.

THE DRAWING FRAME.

As soon as the spread-board bell rings, a girl, called the "frontminder," breaks off the sliver, takes away the full can, and replaces it with an empty one. She then with chalk marks on the can the number of the spread board off which it came; and then rolls it round to a boy whose business is to weigh these cans, keep them from being mixed, and make up the "sets."

Front Minder.

The making up of the sets is performed in this manner: All the set-cans in a preparing room should be balanced to some one weight. Then the beam and scales in which these cans, when full of sliver, are to be weighed, must be balanced with one of these empty cans in it, so that when a full can is weighed the nett weight of sliver is all that the boy has to take note of, and this he marks with chalk in pounds and tenths on the side of the can. This he rolls to the place set apart for the cans from that particular spread board, and when he considers he has a sufficient number to make up the set he places them in a row and tots up their weight. Supposing he finds this in excess of the required weight, say 5 lbs., he picks out the heaviest can and replaces it with one 5 lbs. lighter; or if he has not one so light, with the lightest that he has. By the interchange of a couple or so more cans he can bring the set to add up within an ounce or two of the required weight, and this without any delay and without confusing the spreader by incessant demands for cans above or below her accustomed standard. All that is necessary is that the set-boy may have a sufficiency of cans to make up the set from, and that he gives the spreader timely notice of any decided tendency on her part to spread either too heavy or too light. If this latter evil has not been checked in time the boy is forced to make up a few sets with either fewer or more cans than the proper number. This proper number is two cans for each row of gills in the "head" of the first drawing or set-frame; if there be six, eight, or twelve rows, then should there be 12, 16 or 24 cans in a set.

Making up a Set.

Odd cans, less than this number, are especially injurious from the fact of their causing some one of the pressing rollers to be more or less tilted, there being double the body of material under one of the bosses than there is under the other. The great evil resulting from this is that the tilted boss cannot draw the fibre properly, but sends it out intermittently in thicks and slubs that cannot by any after process be eradicated, but must appear in the yarn in the form of "fishes." Another evil effect is that most of the gills are unnecessarily loaded, putting undue strain on the drawing of the material from them; whilst one or more gills are too lightly loaded.

Evil of odd Cans.

The very same arguments may be used against putting more than the proper number of cans—whether odd or even—in the set; only that the injurious effect is not so apparent.

In some cases, especially for fine work going over "six gill heads," it might be advantageous to put three slivers over each gill, for doublings' sake; but this necessitates much more spreading, and is now generally avoided in modern machinery by the number

Light Slivers.

of rows being eight to each head. Thus the sliver gets every justice; the spreading is not overtaxed; and the number of doublings is ample.

Scarcity of Machinery.

Where preparing machinery is much pressed, it may sometimes be imperative to overload the gills, and in such a case the evil effects may be somewhat lessened by increased leverage being put upon the pressing-rollers. But even this will be at the expense of extra wear and tear of machinery, and of an increase in the power required to drive, in the quantity of oil to lubricate, and of wood to renew the pressing-rollers. Thus can it be seen at a glance that a sufficiency of preparing machinery has its advantages in more ways than in the mere improvement of the preparation.

Compound Leverage.

To find the leverage that is upon a pressing-roller, the pounds and ounces in the weight on the end of the lever must first be ascertained; then, if the lever be of the compound type, multiply this weight by the distance in inches from where it is pending to the centre of the pin on which the end of the lever rotates. This point is called the fulcrum. Then divide this quantity by the distance in inches from the fulcrum to the centre of the pin which connects the extremity of the upper arm to this fulcrum; the quotient will be the power, in pounds weight, that the under lever communicates to the upper. Multiply this weight or power by the distance in inches from the centre of point of connection between the upper and under levers, to the centre of upper lever fulcrum; and the product divided by the distance, in inches, from the upper lever fulcrum to the boss or point in connection with the "spring-wire,"—which communicates the power to the "hanger"—will give for quotient the weight in pounds upon the arbour of the pressing-roller. If the leverage be "simple"—as in most of the old-fashioned machinery—only the former portion of this calculation has to be gone through. We give example of a compound lever calculation:—

Leverage Calculation.

	8	pounds weight.
	18	inches from weight to fulcrum.
Fulcrum to point of connection, inches	3)144	
	48	power transmitted to upper arm.
	14	inches from upper point of connection to fulcrum.
Upper fulcrum to point of connection with spring-wire .... inches	2)672	
	336lbs.	on pressing-roller.

Rule for Leverage.

Too much or too little leverage is injurious in every way; the requisite amount being gauged mainly by, not only the thickness of sliver in the gills, but also by the correct proportioning of the gills and the conductors, points of moment that we intend to discuss more fully farther on. However, these items having received due consideration, the following may be considered a fair statement of the most suitable pressure to be put on the rollers:—Allow 200lbs. pressure for each inch in the breadth of gill; thus a 1″ gill should have 200lbs. on pressing-rollers, a 2″ 400lbs., a 3″ 600lbs., and so on.

Set-frame.

We now return to the "set," which we will suppose to have been put up at the back of the set-frame, and to be now nearly run through. All the cans having been presumably the same length, it is evident that, they having been put up together, it should take them the same time to run out, provided that any of them have not broken, and so become what is known as "dropped ends." But

Irregular Bells.

sometimes they do not run out evenly, and when this happens the cause is easily traceable, and the evil should be at once checked. Either this particular material has been spread on

two or more spread-boards that have not exactly the same length of bell, or the frontminder has been neglecting her duties by not doffing the cans when the bell rang.

Running out a Set.

When, from one of these reasons, the cans do not run through simultaneously, the set has to be, what is technically termed "run out," this giving increased work to the woman tending, called a backminder; tossing the sliver; and lastly, and if anything, worst, causing many unnecessary piecings of the sliver.

Putting up a Set.

Supposing that the set runs out evenly, the set-frame is stopped when only a yard or so of the sliver remains, hanging out of the feed-rollers. The empty cans are then wheeled away, and a set standing ready is rolled into their place. The backminder takes up the end of sliver out of each can, and passing them all over the guides or sliver pulleys, pieces each couple of slivers to one of the ends hanging from the nearest conductor—this piecing is effected by simply overlapping the ends some six or eight inches, and intertwisting them loosely together.

Piecing Sliver.

Sliver Waste.

When all are pieced to their proper ends, the set-frame is again started, and works away as usual. Of necessity there will be a handful of sliver, more or less, made into waste at the piecing up of each set, and if the preparation be extra particular the portion of sliver from front of set-frame, which contains the piecings, should be pulled to waste also. This after being well pulled and straightened, should be tied up in bundles, and when a sufficient quantity has accumulated of this "sliver waste," and also all the other waste made in the room, through "singling," "bad rove," &c., these bundles should be taken to a very coarse spread board, especially adapted for the purpose of "waste spreading." All may be spread together indiscriminately—sliver and rove—the latter drawing perfectly well if it has all been hand-reeled off the "rove-bobbins," and carefully pulled into lengths of about a foot and a half, the twist being partly beaten out of these lengths with a wooden beater, something like the "handle" of a scutching machine.

Treatment of Waste.

The sliver made out of this waste will be found wonderfully level, and quite good enough for mixing with the coarsest lea, by passing in, say, one can in each set regularly. In large establishments there is enough waste made throughout the preparing department to keep one girl constantly spreading it; as the board has to be driven exceedingly slow, to give the spreader time to separate the waste into very small portions, and to free these from any knots, lumps, or impurities that would endanger either "gill" or "pressing roller." Besides, the whole construction of this spread board has to be very coarse and open.

This arrangement of spreading the waste on one spread board will be found far preferable to the too common practice of sending all sliver waste back to the spread board off which it came, no matter how expensive the material or important the preparation. This practice not only tends to damage good sliver by lumping or "napping" it, but also makes the spreaders more careless in the handling of good flax, when they see those in authority satisfied to have rough unshapely pieces of waste spread in along with the fibre. Besides, it is only the best of the sliver waste that these girls—accustomed to free open flax—can spread at all. All the rove waste, and much of the sliver, has to be sent down to the roughing shop, where a rougher is paid one penny per pound "made work" for taking about sixty per cent. of very rough "longs" out of it. This latter is sent to the "hackler," who gets the same money for taking about the same proportion of "dressed line" out of the longs; and this dressed line is, after all, only of a very wefty nature.

The "tow" that comes off the "waste" is not as valuable as the worst in the store, since besides being destitute of strength it is full of lumps and "naps," which are very severe upon the "carding engine," and it can never be carded to the same advantage as fair tow, on account of the quantity of oil that is among some of it, causing it to clog in the pins.

The percentage of waste made in the preparing department is very variable, so much depending on the cleanness of the material and the class of machinery. The range is from 1 to 12 per cent.

Construction of Set-frame.

The construction of the set-frame, or first drawing, is very similar to that of the spread board, only that it is finer in all its parts, has two or three "heads" in the frame, and the back rails and sliver pulleys for guiding the slivers, instead of the "leathers" as in the spread board. Also the gills and fallers are horizontal instead of inclined.

The object of the set-frame is to be the medium whereby the weights of sliver and rove are regulated over the system to which it belongs, and to carry on the preparing process, which, as before remarked, after the spreading may be said to consist of "drafting" and "doubling;" the sliver becoming gradually finer and lighter as it passes over this and succeeding machines.

Weight of Rove and Sliver Calculations.

For instance, suppose it is required to prepare a "rove" to spin to 50's lea, on a spinning draft of 10, the question arises, what must be the weight of rove to spin to 50's leas on 10 of a draft? Now 50's lea yarn means 50 leas or "cuts" to the pound weight. In a cut there are 300 yards, therefore in a pound weight of 50's lea there are 15,000 yards, so that to spin on 10 of a draft there must be 1,500 yards of rove to the pound, or 93·75 yards to the ounce. Then supposing that there is 15 of a draft on the "roving frame," there will be 100 yards of sliver to the lb. delivered from the third drawing frame. Then if there are eight doublings and 14 of a draft on the third drawing that will make 100 × 8 ÷ 14 = 57·14 yards to lb. delivered from the second drawing. If there are 12 doublings and 15 of a draft on the second drawing that will make 57·14 × 12 ÷ 15 = 45·71 yards to lb. delivered off the set-frame. If there are 16 doublings and 15 of a draft on the set frame that will make 45·71 × 16 ÷ 15 = 48·75 yards per lb. delivered from the spread board. This 48·75 yards per lb. divided into the 1,000 yards in "Bell" = 20 lbs. and five-tenths, nett weight of sliver in one "set can;" 328 lbs. in set of sixteen cans, or

$$\frac{1{,}000 \times 15 \times 14 \times 15 \times 15}{93{\cdot}75 \times \text{——} \times 8 \times 12 \times 16} = 328$$

Names.

$$\frac{\text{Yards in Bell} \times \text{Roving Frame Draft} \times \text{Third Drawing Draft} \times \text{Second Drawing Draft} \times \text{First Drawing Draft.}}{\text{Rove, yards per ounce} \times \text{——} \times \text{Third Drawing Doublings} \times \text{Second Drawing Doublings} \times \text{First Drawing Doublings.}}$$

Change of Rove.

Supposing it to be necessary to prepare for a finer count of yarn on the same system, without in any way altering it, say that the rove was required 120 yards per ounce, the weight of the set necessary to give this rove is found by simple proportion, thus: If 328 lbs. rove 93·75 yards, how many pounds will it take to rove 120 yards per ounce? It will take less pounds to produce the lighter rove, therefore

As 120 : 93·75 : : 328 to answer.
93·75
―――
120)30,750
―――
256lbs. in set to rove 120 yards per ounce over this system.

Once preparing systems are started, and the rove proved by reeling, one ounce or half ounce of rove off the roving bobbin, over a yard reel—to simplify the counting of the number of yards per ounce by the revolution of reel—and the weight of set that produced this rove being known, it is easy to arrive at correct answers to all changes in the manner illustrated above. Pounds equivalent to the probable gain or loss per cent. to be incurred by the proposed change must be deducted from or added to the proportionate answer, to keep the rove as near to the required weight as possible.

Starting new Machinery.

It is quite possible for a mistake of many yards per ounce to occur if a new system be started in accordance with the preceding calculation, from various causes.

As, for instance, there is more or less of a lead upon the fallers and delivery roller, which causes a slight variation from the calculated feed and delivery; or it may not be easy to arrive at the exact circumference of the feed and boss rollers, or the "pitch" of some of the gearing may not be exactly correct. This is of frequent occurrence from mistaken allowances being made for contraction in the getting up of the patterns. This incorrect pitch causes an unsteady jarring drive, which is bad for the preparation, and besides, causes the gearing and "studs" to wear away quickly. However, if a mistake of some yards does occur in the starting of a system, this will not matter, as the spinning frame can be drafted to suit; or the weight of the set can be changed in proportion; or the draft of the roving frame can be altered, which is the speediest and commonest mode of procedure. This change is also calculated by simple proportion, thus—Suppose a system has been started, and the rove that was calculated to be 94 yards per ounce comes out 84 yards: then if 15 of a draft on the roving frame produces 84 yards, what draft will produce 94 yards? A longer draft; therefore—

As 84 : 94 : : 15
15

84)1,410

16·8 draft to produce rove 94 yards per ounce.

Then count the teeth in the roving frame-draft change wheel, say 50 teeth, and as by calculation it was shown this wheel gave 15 of a draft, and 16·8 is required, if a wheel draft 15, how many teeth will draft 16·8? More, therefore—

As 15 : 16·8 : : 50
50

15)840·0

56 teeth in change wheel to produce the rove 94 yards per ounce.

In this manner can the drafts be altered on any machine to that required. From the foregoing observations it may be noted that "longer drafts" require a heavier set; and "increased doublings" a lighter set. Of course doublings on the spread board do not affect the weight of the set, but do influence the total doublings over the system. Therefore the number of cans in the set is of no moment in making out the number of yards of rove per ounce, which will be given by a certain weight of set, with certain drafts, doublings, and length of bell. But the number of cans in set is of moment in the finding the number of pounds to be in a set, from the yards per ounce of rove, with certain or similar drafts, doublings, and length of bell. Thus—

Relation between Draft, Doublings, and Set.

A System,

	Draft	Doublings
Spread Board	30	6.
1st Drawing	18	14.
2nd Drawing	16	16.
3rd Drawing	16	8.
Roving	16	—

Length of Bell, 700 yards.
Weight of Set, 183 lbs.

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                                        700 yards in Bell.
                                         18 Draft of 1st Drawing.
                                     ------
                                     12,600
                                         16 Draft of 2nd Drawing.
                                     ------
2nd Drawing Doublings ........... 16)201,600
                                     ------
                                     12,600
                                         16 Draft of 3rd Drawing.
                                     ------
3rd Drawing Doublings ...........  8)201,600
                                     ------
                                     25,200
                                         16 Draft of Roving.
                                     ------
Weight of Set 183lbs.=ounces, 2,928)403,200
                                        138 yards per ounce, Rove.
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Or

$$\frac{700 \times 18 \times 16 \times 16 \times 16}{\text{———} \times 16 \times 8 \times 16 \times 183} = 138 \text{ yards.}$$

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                                        138 yards per ounce (16 drams), Rove.
                                         16 ounces in 1lb.
                                     ------
Roving Frame Draft ...............  16)2,208
                                     ------
                                        138
                                          8 Doublings in 3rd Drawing.
                                     ------
3rd Drawing Draft .................  16)1,104
                                     ------
                                         69
                                         16 Doublings in 2nd Drawing.
                                     ------
2nd Drawing Draft .................  16)1,104
                                     ------
                                         69
                                         14 Doublings in 1st Drawing.
                                     ------
1st Drawing Draft .................   18)966   700 yards in Bell.
                                                14 cans in Set.
                                       ----    ----
Yards per lb. at Spread Board ......  53·7)9,800 yards in Set.
                                             ---
                                              183 lbs. in Set.
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Or

$$\frac{\text{——} \times 16 \times 16 \times 16 \times 18 \times 14 \times 700}{138 \times 8 \times 16 \times 16 \times 14 \times \text{———}} = 183\text{lbs.}$$

Relation between Bell and Set.

As regards the length of the bell, it affects the yards per ounce of rove by proportion, the weight of set, drafts and doublings being unaltered. Thus, if a 1,000 yard bell with a 50lb. set, on certain drafts and doublings, gives 700 yards of rove per ounce, a 500 yard bell, on the same drafts and doublings and weight of set, will give 350 yards of rove per ounce.

Consequently, if a lighter set be required, shorten the bell; and if a heavier, lengthen it. Thus it follows that to keep the weight of set and

the doublings the same, and to shorten drafts, the bell must be lengthened by proportion; and to keep the weight of set and drafts the same, and to increase the doublings, the same alteration must be made, and *vice versa* in each case.

It is only until the sliver be put up in sets that there is any necessity for measuring certain quantities into each can. After the set has been made up, that is, after so many yards in length have been apportioned to so many pounds weight, subsequent draftings only reduce the number of pounds weight to the same number of yards proportionately, the doublings continuing the same.

Therefore the girl—called a drawer—attending the fronts of succeeding machines, can break off a sliver at the front of the first drawing or set frame at any moment she may require it to "piece an end" at the back of the second drawing. Although, as previously remarked, it matters not how many or how few cans there are in a set, so long as there are the stated number of pounds weight; that is, it matters not in relation to the weight or body of the sliver at the front of this set frame, yet when the sliver comes to the other drawing frames it is all important that the stated number should be kept up at their back.

Defective Sliver.

Sometimes a sliver may "run through" one of these drawing frames without the drawer at once perceiving it; this causes the sliver at the front to be so much, in proportion, too light; if there are twelve slivers to one delivery, it will be one-twelfth too light, if there are eight, it will be one-eighth, etc. This difference in the "body" of the sliver, if it occur on the second drawing, and be not let run too long, will not be very noticeable, but on the third drawing, where the sliver is generally doubled for the last time, the loss of such a large percentage of the whole becomes very noticeable when it passes on to the roving frame. The rove is so soft upon the bobbin as to be difficult to wind off without tangling, that is, if it can be wound off at all, from want of twist.

Thus if possible this "singling," as it is called, should never get so far as the rove bobbin, but should be pulled back out of the can at the front of the drawing on which it was made, until all the singling has been drawn out and pulled into the form of sliver waste. The drawer knows when all is pulled out by the size of the sliver between her finger and thumb.

Another cause of singling is stray fibres getting lapped round the "jockey roller," which is the loose pressing roller lying between the two back feed rollers. The slivers are brought through the back conductors of the drawing frame, under the first feed roller, up and over the jockey roller, and down and under the inside roller; so that the jockey roller acts as a retarder, in order that the gills may not "bolt" the sliver, but pin it properly. Odd fibres occasionally lap entirely round the jockey roller, and as it is so nearly surrounded with sliver, these fibres lick in others, until a large lap gathers, and soon the whole sliver is being lapped round instead of passing into the gills. This causes the very worst kind of singling, especially if it occurs on the roving frame, as it is so long in gathering that there may be thousands of yards of rove spoiled before the "lap" is detected. This lap often gathers on the inside feed roller, and before it is noticed gets so large and hard that there is not space for the pins of that row of gills to rise clear of it, and thus they are bent and smashed all the way round. This necessitates the taking out of the "head" of fallers, and their being sent to the "hackle setter's" shop to be renewed, probably at a cost of from 10s. to 30s. for the row.

Smashed Gills.

A still more frequent cause of smashed gills is that the pressing-roller becomes choked or stopped. This may be caused by some irregularity in the sliver; by oil or grease dropping from the shafting, etc., upon the sliver in the gills; by laps of

waste gathering round the arbour ends, as the consequence of the drawer's slovenly habits, or of insufficient lubrication ; or it may be caused by there not being sufficient pressure upon the rollers, or by their not being properly screwed up, etc. Thus the roller stops, and the sliver accumulates in the conductor, and in time becomes so hard as to press with sufficient force against the pins to smash them.

In well regulated preparing rooms all these evils can be more or less avoided by close attention on the part of the overlooker, for there will be, as a natural consequence, more attention on the part of the workers. If the overlooker sees a frame stopped, unless at the proper hours for "brushing out," he should know the cause. Sometimes it may arise from too much or too little stuff; if so he should take means to regulate the speed of that system, so that one machine may supply the other properly.

If, on examining a machine stopped with a "squeeze" caused by a "choke," he finds a large knot or lump in the sliver he must hold the "backminder" accountable, as well as the "drawer," as it is the former's business to allow no tossed sliver to pass into the gills ; and the business of the latter to see the choke, and take it out before damage be done. Small fines, systematically imposed, for all breakages or misdemeanours on the part of his workers, will soon cause greater attention to work, and produce order and discipline, the end at which an efficient overlooker aims. Sometimes a drawer does not trouble herself to pull out singling from the can, but after she has got the backminder to piece the "end" that had run through, she sets on the frame. This singling is thus certain to be "roved," and sent to the spinning frame with the rest, unless the doffers are trained to detain all soft bobbins for examination.

Waste Making. It often happens that the girls are so careless and lazy as not to go to the trouble of pulling the singling to waste as they draw it out of the can. They simply pull out a quantity, more or less as it may happen, and breaking this quantity from the bulk, they throw it into some empty can, to be soon hidden under good sliver. There is nothing that an overlooker should punish more severely than this wilful waste, as if such a practice be not nipped in the bud there is no knowing where it may end. An overlooker who thinks he is getting on smoothly may some day be awakened to the unsatisfactory state of his room by casually examining the interior of a few cans as the sliver is running out of them, and finding them one third or so filled with sliver waste. Further examination will reveal the fact that his whole room is in a similar state. The common excuse will be advanced that this was "done before I came," or "before you came," but this is just one of the things that every manager should permit his overlooker to get put to rights at any cost, and then let him understand that he will have to keep it so. Where the preparing hands are not overwrought, that is, where ordinary care will keep such matters fairly right, it is a very good plan to institute a systematic fine of one penny for each "end dropped," on either spread board, drawing, or roving frame. This will be the surest method of reducing bad spreading and singling—both sliver and rove—and most of the waste resulting therefrom. All "laps" that won't wind off in the form of sliver, to be pulled for spreading, should be cut off and teazed into tow. This and the faller pickings and rubber gatherings should be sent down to be passed through the coarsest "card," just before it is going to receive its weekly cleansing.

Putting in Gear. An overlooker can greatly lessen the recurrence of broken or "squeezed gills," by himself seeing that the arrangement for throwing the machine "out of gear," on any obstruction arising, is in proper working order. If it is the "clutch" style, the spring inside the change wheel socket should be kept free from clogging, and only

compressed so much as to spring on the slightest extraneous strain being imposed on it. If it be the "pin wire," the faces of the change wheel and collar should also be kept free from sticking, by regular supervision.

Licking-up.

If draughts of air are permitted to rush through a room there is nothing more likely to cause "licking up." Therefore all frosty air should be entirely excluded, and an effort made to keep up the same temperature in the room day and night. This should never rise above 60 degrees if possible. Fresh air can be admitted without draught by opening air panes only on the lee side.

Methods of Doubling.

As previously remarked it is sometimes very beneficial—with important and fine preparations—to give the sliver increased doublings. This can be accomplished in one of two ways, first, by giving the sliver more drawings, either by having four drawing frames or by giving it two drawings over the second drawing frame. This is done by taking the sliver from the front of one of the heads of the second drawing, and instead of passing it on to the third drawing, putting it over the second "head" of the same frame, thus giving it the extra drawings, and so doublings. But there is a great objection to this mode of procedure, in that, if the speed of this second drawing frame be left unchanged, it is patent that the delivery from the single head will only be able to supply half as many slivers for the back of the succeeding frame, so that instead of having eight slivers going in at the back of the third drawing to each "delivery" at front, it is necessary to work with only four slivers, or else reduce the speed of the third drawing one half, and consequently to do the same with the roving frame. This would double the cost of preparation. If this is not done, either the drafts will have to be greatly lengthened, or else the speed of the second drawing will have to be doubled, both of which arrangements would be quite as injurious to the preparation as that first mentioned would be costly. If one or other of these expedients is not resorted to, it is necessary to fall back upon the single sliver over each gill of the drawing succeeding that in which the sliver receives the two drawings. This device has also its evil effects from the fact that "doublings" are lost when they become most needed, that is, when the sliver is becoming lightest, and receiving its final doublings. When there are only four slivers into one on the third or finishing drawing, besides "shirey" yarn, there will be a tendency to "slubs," as in this case the piecing of the slivers at the finishing drawing back, will be doubly noticeable. Besides all this, having only four slivers doubled into one instead of eight, necessitates the making of the "set" exactly double the weight to produce the same weight of "rove," the drafts being unaltered.

Having to resort to the device of a very heavy set is highly injurious to the preparation, as the gills of the set-frame and second drawing are overloaded, this causing the "fishing" and lumping of the sliver, from the pressing rollers becoming bruised or "spoiled" by having too great a volume of fibre to draw from the gill. Also when this thick and dense sliver comes to be drawn over the next frame it does not draw with as much freedom as would two slivers of the same conjoint density, if properly drawn. The only advantages accruing from putting heavy single slivers over the frames, are first, the procuring of a heavy set ; secondly, the economising of cans, and consequently of the space occupied by them.

In the first case there is an advantage only where the preparation becomes so very delicate and fine that to get the sliver to travel at all on the doubling plate of the spread-board, the set, and so the cans, must be made heavier ; or else recourse must be had to the expedients of spreading the fibre only on the four gills which are nearest to the delivery, to give the sliver strength to carry its weight, or of putting fewer cans in the set. Both these plans

lessen the number of doublings. Nothing should cause the resorting to the second expedient of putting in fewer cans, except dire pinching for space.

Economising Space.

But where the economising of room is an imperative consideration this reduction of the number of cans can be carried even to the back of second drawing, by putting up both sets at the back of the first drawing at the same time, and doubling them together along both heads of the frame, into one delivery or sliver, at the front. This, of course, allows of only one sliver per gill on the second drawing frame—the end aimed at, where economising of space, and not superiority of preparation, is the *desideratum.*

Brass Doubling Plates.

On systems where the preparation is so very delicate and fine that much difficulty is experienced in getting the sliver to travel along the doubling-plate ; these plates, if made of brass instead of iron, have been found to go far towards the removal of this evil, as the variation of temperature is not registered so markedly by the brass—in the form of stickiness or moisture—as it is on the surface of iron.

Overflowing Cans.

A very great, but avoidable, evil in preparing, is the putting of too much sliver into the set cans, or indeed, into any sliver can. For this reason, besides the greatly increased amount of labour imposed on the women, in their efforts to prevent the sliver from overflowing and becoming tossed and dirtied on the floor, the sliver becomes so crimpled with the pressure brought to bear upon it that this crimp will not leave it, but passes into the back of the succeeding machines. This means that there is a large percentage more sliver passing in in this form, than if it were limp and stretched like the other sliver with which it may perchance be passing in at the moment. These two slivers are pressed together unevenly, given into the fallers in this form, and consequently are drawn out more or less uneven, and heavier than is correct.

Variations in Rove.

When this "lurking" of the sliver occurs over all the slivers of an overflowing set, just pieced up, it is really a serious matter, and will to a great extent account for those mysterious variations in the weight of the rove, which will sometimes occur, no matter how carefully the sets be weighed and put up. But it may be said why not put more cans in the set, and so prevent this evil? There are likely to be various reasons for not doing so, among others there may not be room, nor cans, nor enough spreading or drawing, or it would be choosing the worst of two evils to put an odd can in the set, and so have a heavy and a light sliver under the bosses of the same pressing-roller. This last evil, as before remarked, is sure to injure the sliver, and besides will fray or ruffle the lighter of the two slivers by the friction raised between the bosses of the delivery and pressing rollers, between which the lighter sliver passes. For this reason, besides keeping the same weight of sliver under each boss, the line of centres of the pressing rollers should set exactly over the line of centres of the boss roller. This can be effected by having the slide of the "yews" on perfect line with one another, and with the boss roller, and the washers or "brasses" which work in these slides exactly the same diameter, and truly bored, so that the ends of the axle of the pressing roller, being of similar diameter when covered with these brasses, the roller when lifted into its place will sit straight and true upon the centre line of the boss roller.

Position of Pressing-rollers.

When preparing machinery becomes old and worn, the axles of these pressing rollers, and the slides of the yews are portions that display this fact fully. The rollers have much "play room," so much sometimes as not to cover the conductor entirely, especially if the conductor also be worn and loose. Then may the

Origin of Slubs.

material be said to be "murdered" in the preparation, as any portion that is not gripped by the pressing roller slowly comes forward at the same rate as the speed of the faller, and when it becomes too large to fill the space between the conductor and the pressing roller face, it is caught up by the latter, and drawn into the sliver in the form of a large lump or slub that will never again be eradicated from either sliver or yarn. Slubs are also frequently formed in the sliver, by the front conductors not encircling the inside face of the boss roller with sufficient closeness. The fibre gathers about the heel of the conductor, and when a sufficient quantity accumulates it is drawn up outside the conductor, and into the sliver. A well formed front conductor will closely embrace fully one-third of the surface of the boss roller—from toe to heel. When the pressing rollers will not cover the conductors, from wear, they have to be made broader in the face to effect this. This curtails their drawing power, if it does not put the frame entirely past work, for this reason: the soft timber soon becomes indented with the flax, whereas the iron surface does not. Now the pressing roller derives its velocity from the surface speed of the boss roller, or rather of the fibre which rests upon it. Therefore on account of the thickness of this fibre its velocity is something greater than the velocity of the boss roller itself; and as it is the velocity of the body of sliver that is communicated to the surface of the pressing roller, the latter, in consequence, travels infinitessimally faster than the boss roller. This produces friction between the portions of the pressing roller that are not resting on the fibre, and the corresponding surface of the boss roller. This friction in time wears away the iron surface, the wood perpetually being changed and renewed. This leaves a height for the fibre to be drawn upon, and a cavity at each side on the surface of the iron or boss roller. As the brass conductor becomes widened by the constant friction of the sliver passing through, portions of the fibre escape into these cavities, and are not drawn away until a sufficient quantity has gathered. Indented boss rollers may thus be looked upon as the root of all ills in preparing, as these gatherings not only destroy the levelness of the sliver, but soon spoil any pressing roller that may be introduced, and cause loss of time and wood in changing. Consequently boss rollers should always be taken out of the frame, and sent to the mechanics' shop to be "skimmed up" in the lathe when they show the slightest signs of indention, which will be every eighteen months or sooner. Where, from scarcity of preparing machinery, mechanics, etc., etc., it may not be convenient to clean up the boss roller, even if excessively bad, the expedient is sometimes adopted of contracting the brass conductors, but this may put it beyond the power of the pressing rollers to draw on account of the heavy selvage, or it may at least damage them sooner; besides the fibre will not get justice. It is true economy to keep all preparing machinery in thorough order and repair, and not to be chary in replacing it with new when it shows the least signs of being past work.

Friction between Rollers.

Skimming-up.

Fractions of Sets.

It is often found convenient, if not absolutely necessary, to be able to put an exact number of pounds weight of material, which may be limited in amount, or of some unusual or peculiar kind, over a system. This is quite feasible, as any fractional part of the weight of a set can be passed through, provided there be exactly the proportionate number of yards of sliver to this fractional weight. For example, if the weight of the set be 180lbs., with say a 900 yards bell, and that only 60lbs. of a certain class of material is to be spread, but with rove the same number of yards per ounce, then if in the set there are 18 cans of 900 yards each, by proportion we find, that if six cans of 900 yards each, and 10lbs. weight each, or 60lbs. in all, are each reeled, or separated by

weight into three short cans of 300 yards each, we shall then have $6 \times 3 = 18$ cans of 300 yards each in length, and 3lbs. 5·3oz. each in weight; or the required 60lbs. to the proportionate yards, viz., 5,400 in all. This will produce a similar weight of sliver and rove to the ordinary set. Again, if with 90lbs. the same weight of rove is desired over a system with a 240lb. set of 16 cans, 700 yards bell; then if 16 cans = 240lbs., how many cans = 90lbs.? Six cans. If the 16 cans are 700 yards each, how many yards to each of the six cans? 262 yards. Therefore if each of the six cans be divided into portions of 262 yards each, this will give 16 cans of 262 yards each to the 90 lbs., which is proportionate.

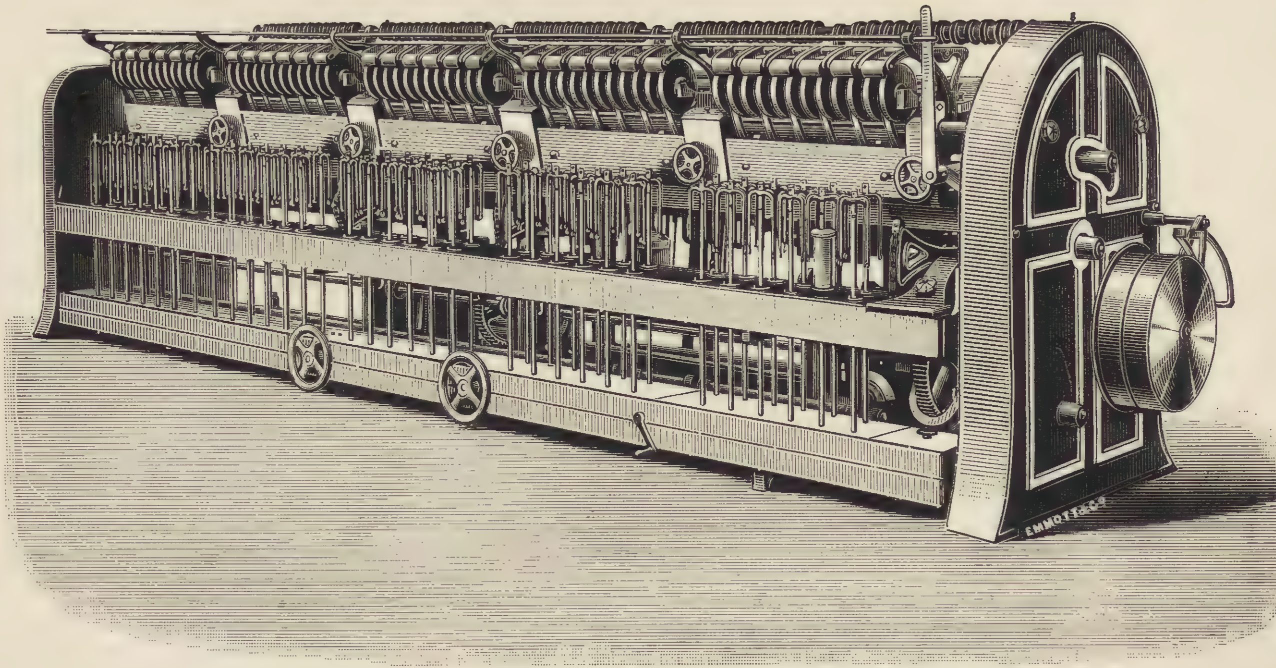
Loading of Gills. We have already referred to the necessity of the gills not being over-loaded with fibre. There have been many rules laid down for guidance in this matter, but none in the writer's opinion, that are sufficiently comprehensive. There are so many contingencies—as proportions of conductor, both back and front, to the breadth of gill; the density of the pins in the gill, and their length; the available leverage for the pressing-rollers, etc., etc., that it seems well-nigh impossible to lay down any reliable rule on this subject.

If the gills pin the sliver with ease, and the latter be not bearing on the stock or bottom of the gill, and shows no tendency to ride out of or over the tops of the pins, during the drafting; and if the pressing-rollers seem to draw the fibre with freedom and ease, without the selvage of the sliver being much more dense than the body—which would quickly spoil the rollers—or much lighter, in which case it would have a tendency to "lick up" round the rollers; then may it be safely affirmed that the material receives every advantage.

Rule for Proportioning Gills. The following rule will be found to embrace, as far as possible, all these *desiderata*:—The square root of the coarsest lea to be passed over the system, when divided into each of the constant numbers 20, 15, 12, 10, and 7, will give the necessary "breadth of gill" of the spread-board, set-frame, second drawing, third drawing and roving-frame, composing that system. If the system comprises a fourth drawing-frame, then the square root of the coarsest lea divided into eight, will give the breadth of gill for that frame.

Preparing essentials. In short, besides well adapted machinery, too much importance cannot be attached to the necessity for practising the greatest order and accuracy in every stage of the preparing process; in even piecing out and spreading; in level-drawing and regular doubling; in keeping the machinery in excellent repair; and in the reservation of all waste, for separate treatment.

Origin of Poor Yarn. A simple calculation will clearly show the irreparable damage resulting to yarn from apparently the most trivial irregularities in the preparing room. Take the case of waste being spread among pure dressed line, say that the front-minder throws back to a spreader a handful of waste made at the front of her spread-board, through her own careless spreading, and which must be put out of the overseer's sight; she takes this, tears it into rough uneven lengths, and fills up the "leathers," say to the length of one yard, with this waste. It is plain that if there is 30 of a draft on that spread board, there will be 30 yards of sliver deteriorated by this waste. This 30 yards goes up at the back of the "set frame," and is drawn, say 16 times, making 480 yards of sliver injured. The 480 yards go up at the back of the second drawing, and are drawn, say 16 times, making 7,680 yards. This 7,680 yards goes up at the back of the third drawing, and is drawn, say 14 times, making 107,520 yards. These 107,520 yards are drafted, say 15 times, on the roving frame, making 1,612,800 yards; or over 900 miles of rove that cannot be (regarded as) entirely free from deterioration consequent upon the introduction of that single yard of frayed and tossed fibre into the preparation.



ROVING FRAME.

CHAPTER IX.

THE ROVING FRAME.

THE roving-frame, the last machine over which the material is passed in the preparing department, is a long rectangular frame, with any number of "heads" from four to seven, in each machine; and any number of rows of gills, as 8, 10 or 12, per head, according to taste. Over these gills only single slivers pass, so that there is only drafting, and not doubling on the roving-frame.

Structure of Roving-frame.

Flyer and Spindle.

When the sliver is drafted to the requisite size, it, on being delivered from the boss-roller, passes through the neck of the "flyer"—an iron tube something of the shape of an inverted U, which is fixed upon the top of an upright revolving spindle—then through a slit in the leg of the flyer, and through the flyer-eye, on to the barrel of a bobbin, revolving round the spindle, and under the flyer.

Rove.

The effect of this arrangement at the roving-frame front, is to put twist into the attenuated sliver—now called "rove" —to give it some strength, and at the same time to lap or wind the rove evenly, levelly, and without strain, over all the barrel of the bobbin.

The Bobbin.

The placing of the rove upon the bobbin is accomplished by the spindle and bobbin revolving at different velocities in the same direction; the difference in speed between the two being the means by which the flyer is enabled to lap the strands round the barrel. The bobbin at the same time slowly travels up and down the spindle blade, so as to receive the rove in an even layer. This traversing motion is caused by the bobbins resting upon a moveable tray surrounding the spindles, which contains the gearing to drive the bobbins at the required speed, and rises and falls regularly, thereby causing the building of the rove on the bobbin. It is called a "builder," and its speed per minute, and the revolutions of the bobbins are made to vary as each layer passes on the bobbin; so that there may be no difference on the tension of the rove by the alteration in the circumference of the barrel, as each row is added. The mechanism which effects this really exquisite motion is called the "differential motion." This will be best explained by giving the relative speeds and the names of the various parts forming this arrangement, which are as follow :—

The Builder.

Differential Motion Calculation.

	180	revolutions per minute of bottom driving shaft of roving-frame.
	84	speed wheel.
Stud wheel	64)15120	
	236·25	
	34	stud driver (twist or change wheel).
Upper cone wheel	40)8032·50	
	200·81	speed of upper cone.
	18·12	upper cone circumference at start of doff.

Bottom cone circumference at start	10·58)3638·68	
	344	speed of bottom cone at start of doff.
	15	cone pinion.
Crown shaft wheel	60)5160	
	86	speed of crown shaft.
	27	crown driver.
Crown wheel	105)2322	
	22·11	speed of crown wheel at start of doff.
	2	double action.
	44·22	power of crown.

	180	speed of bottom shaft.
	62	driving bevel.
Driven bevel................	62)11160	
	180	speed of socket shaft.
	105	socket wheel.
Bobbin shaft wheel	60)18900	
	315	speed of bobbin shaft, if without crown.
	28	bobbin shaft bevel.
Wharve wheel	19)8820	
	464·21	speed of bobbin, if without crown.

	180·00	speed of bottom shaft.
	44·22	power of crown.
	135·78	actual speed of socket shaft, at start of doff.
	105	socket wheel.
Bobbin shaft wheel	60·0)14256·90	
	237·61	actual speed of bobbin shaft.
	28	bobbin shaft bevel.
Wharve wheel..............	19·0)6653·08	
	350·16	actual speed of bobbin, at start of doff.

	180	speed of bottom shaft.
	84	speed wheel.
Spindle shaft wheel..........	48)15120	
	315	speed of spindle shaft.
	28	spindle shaft bevel.
Spindle wheel................	19)8820	
	464·21	speed of spindle.
	350·16	speed of bobbin.
	114·05	receiving speed of bobbin.
	3·92	circumference of barrel.
	447·08	inches received on to bobbin at start per minute.

	180	speed of bottom shaft.
	84	speed wheel.
Stud wheel	64)15120	
	236·25	
	34	stud driver.
Boss-roller wheel	102·°)8032·50	
	78·75	speed of boss-roller.
	5·87	circumference of boss-roller.
	462·26	inches delivered per minute.
	447·08	inches received per minute.
	15·18	inches contracted by "twist" per minute.

These calculations are taken from one of Lawson and Son's long lins roving frames of modern make. The cones mentioned are primary meane by which the speed of the bobbins is altered, in this way:—The upper cone is in connection with the gearing of the frame, and consequently its revolutions per minute never alter. But on account of the diameter of one end being about three times as great as that of the other, the shifting of a belt along the surface of the upper cone may be made the means of communicating very different speeds to the under cone; especially as the latter is the same shape, but set inversely and parallel to the former. Therefore, on the shifting of the belt connecting these two cones depends the whole motion. The belt is shifted about a quarter of an inch, or any required length, at every rising and falling of the builder, by an ingenious rat-trap motion. This belt is placed on the larger end of the upper cone at the commencement, so that the under cone goes at its greatest speed at the starting of a fresh set of bobbins, or, as it is commonly called, the commencement of the doff. This bottom or under cone is in gear with a wheel forming part of the "differential motion," and called the "crown wheel."

Crown Wheel.

This large wheel has small bevel wheels inserted on each side of and parallel to its axle. The revolving of the crown wheel, which is regulated by the speed of the under cone, carries round these intermediate bevels, and as their centres bisect the radius of the crown wheel, they have twice its power; that is, for one revolution of the crown wheel they, if held in gear with a bevel of their own size, will turn round twice on their own axles. As before-mentioned, the crown wheel is acted upon by the bottom cone, but the driving shaft of the roving frame passes through the centre of the crown wheel, so that a careless observer might think it is the driving shaft which gives motion to the crown wheel. Not so, however, as the latter is a socket wheel. But if the driving shaft does not give motion to the crown wheel, it communicates motion through it in this manner. There is a bevel wheel of similar size and shape to those in the crown wheel keyed on to the driving shaft, and at the opposite side of the crown wheel from the gearing end of the frame. This bevel is in gear with the intermediate bevels in the crown wheel, and always goes at one speed, viz., that of the driving shaft. At the other side of the crown wheel there is another bevel wheel loose upon the driving shaft, like the crown wheel. This bevel is the same in every respect as the others, and is in gear with the intermediates. Thus the tight or driving bevel communicates its power through the intermediates, to the loose or driven bevel, which, by the intervention of other wheels, is in gear with the bobbin shaft; this latter train is called the "link motion."

Link Motion.

It is not to be understood that the driving bevel communicates its own revolutions to the driven, as the crown wheel is revolving in the same

direction as the former, and gives the intermediate bevels twice its own power. Thus, to get the actual speed of the driven bevel, twice the revolutions of the crown wheel have to be deducted from the speed of the driving bevel. This phase of the motion being thoroughly understood, it is very easy to follow the rest.

Power of Crown.

The reason it is called the "differential motion" is that the quicker the crown wheel revolves the less power the driving bevel has upon the driven, and therefore the slower the bobbins go, and the slower the crown wheel revolves the more power the driving bevel has upon the driven, consequently the bobbins go the quicker. And as the under cone is driven quickest at the commencement of the doff so the crown wheel goes quicker, and therefore the bobbins slower, that the flyer may get time to lap the end of the rove round the small circumference of the bobbin barrel. The fuller the bobbins become the under cone and crown wheel go the slower, so that the bobbin may go faster, approximating in speed more closely to the flyer, and thus making up for the increased length of rove that one revolution of the flyer lays round the enlarged circumference of the bobbin. By the proper cutting of the cone, and the desired shift of the cone belt, as each layer passes on to the bobbin, the same even tension is kept on the rove from the commencement of the doff to the finish.

Speed of Bobbins.

The breaking of the cone belt, if not speedily observed by the girl attending, called a "rover," causes the loss of time and waste. This arises from the extreme tension put upon the ends, causing the rove to become "dragged" and hard built on the bobbin. By this dragging the strength is taken out of the rove, which makes it unfit to come through the spinning troughs, and so renders it useless except for waste.

Dragged Rove.

As the reader will observe, from careful consideration of the preceding remarks upon the action of the bobbin motion, the natural effect of the breaking of the cone belt would be the stopping of the bottom cone, and therefore of the crown wheel. It might be expected that this would leave the driving bevel full power, and consequently increase the speed of the bobbins, so causing the ends to run slack. An effect directly opposite to this is produced, however, as the resistance against the driving bevel, by the weight of the gearing—all the driving to the bobbins—on the driven bevel, causes the crown wheel and bottom cone to be carried round by the driving bevel to the proportionate loss of power. Thus the bobbins really go very slowly and therefore drag the rove.

The strength of sixty or seventy ends of rove is sufficient to carry on the bobbins, and so retards the speed that the driving bevel would put upon the crown wheel, so long as the ends do not break. Thus a frame might run for a whole doff without any cone belt, but the rove on the bobbins would be nearly as hard as the barrel of the bobbin itself, and without strength.

There are cases where odd rove bobbins are very hard, and yet the rove so strong that it can scarcely be broken—a sure proof of carelessness on the part of either the rover or the backminder. This defect may be caused in various ways. As, for instance, there may happen to be a lump in the sliver as it is passing through the rollers of the roving frame. This lump may cause the momentary "choking" of the pressing roller, and therefore the breaking of the end of the rove. If the lump be not very large, the roller may have the power to gorge it through, when the loose end immediately laps round some other end of rove, and is carried down by the flyer, passes round the barrel of the bobbin, twice as thick and about four times as much twisted as the ordinary rove. This is called "double

rove," and if the rover does not detect it at once, the rove on this bobbin will become as hard as a stick; and if it be passed on to the spinning frame will destroy the pressing roller and "shire" the end spinning under the other boss. If the "reeler" also fails to detect this double yarn and cut it out, there will be a strong rib running through the cloth, to its detriment. Again, the passing of an end through the back conductor of the roving frame before the backminder has had time to lay a sufficient lap of the end to be pieced, against it, causes a thin part or shire, as it is called, in the sliver. This part, as soon as it passes through the front rollers may break and fly loose, as above described, and be another cause of double rove.

Double Rove.

Double rove may also be produced by the backminder carelessly leaving a loose end of sliver hanging over the back rail. This may become entangled with one of the ends passing in to the frame, and so be drawn in with it, overloading the gill, and perhaps choking the pressing roller, causing a "squeeze," if it does not produce this double rove.

Spoiled Rove.

When there happens to be a heavy sliver under one boss of the pressing roller, and the lighter one under the other, the roller is knocked off its seat, drawing the lighter rove unevenly, so as to make it full of lumps and corresponding shires. The twist runs into the lesser or thin parts, leaving the thick without any, consequently this bad rove has no strength, and is only fit to be pulled to waste.

There may be other causes for bad rove; for example, the pressing-roller may not have been screwed up properly; or the wood of which the bosses are made may be unseasoned, and in consequence one or more of the bosses may have become slack on the arbours, or may be cast; the effect of which is that the fibres are not properly and evenly drawn, and so the rove is spoiled. Although the "hands" very well know that they should not allow either single, or double, or spoiled rove to leave the preparing room, yet they are to a certain extent tempted to overlook these cases, as if rove be wound off the barrel of the bobbin, there can be no further filling of that bobbin during that doff, nor until the succeeding doff be filled to the same size as the bobbin in question, on account of the differential motion.

Soft Rove.

Sometimes very soft built bobbins come off a doff, that are not "singling," the rove being strong and heavy as any of the rest, and quite capable of being spun. This soft rove is made in this way. The "wharves" or bobbin carriers have a pin set in them which enters a hole bored in the bottom of the rove bobbin. If the bottom of this bobbin be made of green wood, it is liable to cast, with the heat of the creel board of the spinning frame. This casting or warping causes a displacement of the hole, so that the pin in wharve cannot enter. Thus the bobbin is not retarded in any way, but is dragged round by the velocity of the spindle and strength of the rove in the filling process, the rove being thus built on the bobbin quite soft and uneven. Bobbins that warp in this manner are fit for little else than firewood, and show the necessity for procuring only such as are made of the best possible timber, thoroughly seasoned. Soft built rove may also be caused by the pin falling out of the wharve, but it is not a difficult matter to have a new one rivetted in.

Sizes of Bobbins.

The diameter of spindle blade and the "pitch" of the wharves pins of all the roving frames in a room should be as nearly as possible similar. It is an unending trouble and expense to have too many different sizes and fits of rove bobbins, as besides always getting mixed, it takes a much greater number of each sort to supply the roving frames than if there were fewer sizes. There are various sorts of wood which will make a very fair and durable rove bobbin, as for instance, willow, beech, elm, alder, sycamore, elder, ash, mahogany, etc.; but, all things considered, the best rove-bobbin is composed of beech heads and ash

barrels. The wood having been thoroughly seasoned before being cut up, and, after being fashioned into bobbins, again, seasoned for, say, a year; after having received three coats of paint on their heads to exclude, as far as possible, the moisture and heat to which they are subjected in the spinning-room, the bobbins may then be considered fit to endure the never-ending wear and tear to which they are subjected. Bobbins of this class, if with proper tennons, are capable of being repaired frequently.

Rove Bobbin Making.

When timber is cheap, an exceedingly durable and cheaply constructed bobbin can be made of beech, out of the solid; but it is no use trying this unless the timber be thoroughly seasoned.

Uniformity of Roving Drafts.

Besides the uniformity of bobbin which has been recommended, there is also a great advantage in having all the roving frames themselves, that are adapted for similarity of work, on similar "draft." In this case, when there is too little rove of one sort, and too much of another, a "head" or two of the scarce sort can be roved over the frame that has too much rove before it. This will often save a great deal of changing and inconvenience in the spinning department; and besides, if the rove bobbins be rather scarce, it will prevent all the spare bobbins being filled with rove that is not needed, to the hindrance of the production of other sorts that are required, from the rovings being stopped for want of bobbins. But supposing that the drafts of two roving frames are the same, and the weight per ounce of the two sorts of rove to be prepared over them, is the same also, it does not follow that the two sorts will rove properly together, as a poor, week, short, wefty flax requires more twist in the rove to bring it through the spinning troughs, than a warpy flax does. Thus, if the attempt were made to rove over the same frame two sorts of rove of the same weight, but one a warp and the other a weft, either the warp sort would have to be twisted so hard to allow of the weft being right, that the warp rove would cut up the spinning rollers, and so cause "beaded" yarn; or the weft would be so weak, from insufficient twist, as not to come through the troughs, and so be completely spoiled.

How to Twist Rove.

To overcome this twist difficulty it is necessary to put the poorer class of stuff over a roving frame that is roving some yards per ounce lighter, so that it may get the increased twist. But the weft rove must not be so much heavier as to be built too hard on the bobbin, and so be ratched or dragged; nor yet must the heavier be built properly, at the expense of building the lighter too soft, as by this course the chance of the latter being tossed and ravelled would be greatly increased, and at the same time more doffing of the frame would be required, to the loss of "turn off." These remarks will apply *mutatis mutandis*, where a head or two of a warp number is to be wrought over a frame roving wefts. Thus it will be seen that it requires discrimination in the selection of a roving frame to rove two different classes of stuff properly. These remarks apply also to cases where it is necessary to prepare two or more different sorts over one system. For this reason it is impossible to lay down any rule for the finding of the correct twist to be put in different sorts of rove. Where the class of material in the different sorts is something similar, it is approximately correct to multiply the square of the twist wheel in work by the yards per ounce it is twisting; then, to divide the result by the yards per ounce of the rove to be twisted, the square root of the quotient being the answer sought.

To show how fallacious this rule would become in special cases, the writer may state that he has seen a change of 40 yards per ounce in the weight of the new rove, properly twisted, without any change of twist wheel whatever. Besides the alteration of the twist for a new count of rove, if there be much variation in the weight, the index wheel must

also be changed. This wheel is placed on a stud under the roving frame, and in connection with the rat-trap motion for shifting the cone belt. The turning of this index shifts a rack to which is attached a fork guiding the cone belt. There are "detents" above and below this wheel, which drop into its teeth and prevent it revolving as it would otherwise do, there being weight and chain leverage brought to bear on its axle. Each time the "builder" rises and falls, one of the detents is raised out of position, and so the rack slips forward a short distance, on the index wheel shifting this tooth. Thus the shift of cone belt depends upon the index wheel, and as all indexes are made the same diameter for each class of frame, it follows that the fewer teeth there are in the index the larger they are. Consequently the slipping of one tooth in a coarse index—or one with few teeth—gives far greater shift to the rack, and so to the cone belt, and *vice versa*. Now the coarser and heavier the rove the more room it will require on the bobbin, and the finer and lighter the rove, the less it will require. So on changing to coarser counts, there has to be an index wheel with fewer teeth, and on changing to a finer count, an index with more teeth.

How to Build Rove.

This calculation is also performed by square root, as for example: If a 40 index wheel build rove 190 yards, how many teeth will build rove 230 yards? More, therefore, as—

$$\begin{array}{r} 40 \\ 40 \\ \hline 1600 \\ 230 \\ \hline 190)36800 \\ \hline \end{array}$$

$\sqrt{1937}$ = 44 teeth to build 230 yards.

A simpler method, and nearly as accurate, is to work by proportion; add the old index to the quotient, and divide the total thus obtained by two.

EXAMPLE.—If a 40 index wheel build rove 190 yards, how many teeth will build rove 230 yards? More, therefore, as—

$$190 : 230 :: 40$$

$$\begin{array}{r} 40 \\ \hline 190)9200 \\ \hline 48 \\ 40 \\ \hline 2)88 \\ \hline 44 \end{array}$$

48 by proportion.
40 old index wheel.

44 teeth to build 230 yards.

Sometimes the exact index wheel that may be required for a new count cannot be procured, or it may be found that the strands of rove lie too near or too far apart on the bobbin, and thus prevent the rove having the same level appearance on the bobbin. Now, the builder, as before remarked, alters its speed in the same ratio as the differential motion, but this variation only meets the ever increasing time that it takes the flyer to lap one row of rove round the enlarging circumference, without regard to change in the thickness of the rove itself.

To obviate this tendency to uneven build, the speed of the builder can be altered, by changing the builder pinion, which is connected with the rat-trap motion. If the requisite index wheel cannot be procured, the rove

can be built on the bobbin to the proper density, by the alteration of the speed of builder; but this may be at the expense of the appearance of the rove, as it lies on the bobbin.

If the strands of rove appear over-ridden; or the only procurable index wheel be too fine, a larger builder pinion will regulate matters. If the strands lie too open; or the only procurable index wheel be too coarse, a smaller builder pinion is necessary.

The most practical method of finding whether the speed of builder is proportionate to the thickness of rove is to lap a piece of white paper round the outside layer of rove on the bobbin, as it is being filled, and to allow the succeeding row to be built over it; when correct there will be space for each strand to rest between twó in the preceding row, without falling exactly to their level.

In setting the index wheel it is all important that the detents, when not in contact, should rest exactly over the centre of the teeth; as otherwise, every alternate shift one of them may not act, whilst the other drops two teeth, giving the rove a dragged, corrugated, appearance on the bobbin, and being injurious to it besides.

The Sliver-roving Frame.

A roving frame without any of the above motions or arrangements—as on it the rove was not twisted—has been long in use, but is now nearly obsolete. It was called the sliver-roving frame, and its object was to admit of the production of the most level yarn possible by spinning on extremely short "reaches."

It is undoubtedly a fact that untwisted rove can be spun over shorter "reaches" than twisted rove, but it is very questionable whether the gain in levelness is not more than counterbalanced by the yarn being weakened and damaged in appearance from the fibre having been so much broken up or pulped between the spinning rollers.

Importance of Twist.

Moderate twist in rove holds or binds the weaker and stronger fibres together, allowing them to be "levelly" drafted, with the minimum smashing. This is proved by the fact that rove too slackly twisted has a greater tendency to spin into shirey yarn than if it be sufficiently twisted. In fact yarns of a wefty nature have often been noticeably improved in appearance and strength by the rove being a little hardened in twist.

The sliver-rove was produced in the usual manner from the boss-roller, then it passed through a cold water dip, or trough, over a large cylinder filled with steam; and thence in a dry state on to the bobbins, working horizontally. The damping and quick drying of the thin sliver made it nearly as strong as if moderately twisted.

The bobbins were doffed indiscriminately as they filled, and replaced by empty ones. No necessity for a differential motion. The production off this style of roving-frame was not the half of that turned off the more recent. This much increased the cost of the preparation.

Roving-frame turn off.

The work that a roving frame turns off is estimated by the "rove-cuts" per roving spindle. The cuts being known it is easy to calculate how many spinning spindles each roving spindle should supply. A cut is always 300 yards in length.

A Cut.

Rules for rove-cut.

A speedy method of calculating the rove-cuts is to multiply the revolutions per minute of the roving-frame boss-roller by its diameter. The quotient, divided by 7·7, will give the rove-cut per spindle per day of $9\frac{1}{2}$ hours, 20 per cent. being included for loss by stoppage, contraction by twist and waste. If this rove-cut be multiplied by the draft on spinning-frame and divided by the gross spinning cuts, the result will be the number of spinning spindles supplied by one roving spindle. Example:—

90 revolutions of roving-frame boss roller per minute.
2·5 inches diameter.

7·7)225·0

29·2 rove-cuts per roving spindle.
11 draft on spinning-frame.

Gross spinning cuts = 14·5)321·2

22·15 spinning spindles supplied by one roving spindle.

Another way to find the rove-cut is to divide the revolutions per minute of the roving-frame spindle by the turns per inch of twist being put into the rove, and this quotient divided by the number 24·1 will give for answer the rove-cut, 20 per cent. being included for loss by stoppage, contraction, and waste. Example :—

Turns per inch in rove = 1·1)777·0 = revolutions of roving-spindles per minute.

24·1)706·4

29·3 rove-cuts per spindle.

Based upon this latter method of making the calculation we give on the two following pages a Roving-frame Turn Off Sheet.

Overdriving.

In this table the great range of "speed of spindle" is remarkable, but unfortunately there are roving spindles driven at even 800 revolutions per minute. We say unfortunately, because so it really is, to have to drive preparing machinery at such a ruinous speed. Nothing is more injurious to both material and machinery, as we hope, further on, to prove conclusively. The question proposed in preparing should be, how slow can the machinery be driven, and yet supply the spinning spindles on short enough spinning draft? Subjoined are given the calculations for arranging this, and the question of "supply."

Speeding a System Calculations.

The following particulars of each machine in the system are required: The boss-wheel, boss-roller circumference, draft, slivers per frame, deliveries per frame, pulley diameter, drum diameter, and revolutions of driving shaft. Or tabulated :—

	Boss-roller wheel.	Boss-roller circumference	Draft.	Slivers per frame.	Deliveries per frame.	Pulley diameter.	Drum diameter.	Revolutions of driving shaft.	Total inches off frame.
Spread Board	48	8·67	30	1	1	20in.	12in.	180	780
1st Drawing	63	7·06	16	32	2	20in.	12in.	180	780
2nd Drawing	63	6·28	16	32	2	20in.	12in.	180	780
3rd Drawing	63	5·49	16	48	6	20in.	12in.	180	1,560
Roving Frame	50	5·49	16	60	60	20in.	14in.	180	24,960

Then, revolutions per minute of spread-board boss-roller, × boss-wheel, × pulley dia. ÷ revolutions of driving shaft ÷ drum dia. = spread-board speed wheel.

Vice versa.

Total inches off first drawing, ÷ 1st drawing deliveries, ÷ 1st drawing draft, × total slivers on 1st drawing, ÷ deliveries on spread board ÷ spread-

Table of Rove-Cut.

Table of Rove Cut per Spindle; per Day of 9⅓ Hours.

Turns per Inch.. Revols. Spindle.	·45	·50	·55	·60	·65	·70	·75	·80
300........	27·7	24·9	22·6	20·7	19·1	17·8	16·6	15·6
310........	28·6	25·7	23·4	21·4	19·8	18·4	17·1	16·1
320........	29·5	26·5	24·1	22·1	20·4	19·0	17·7	16·6
330........	30·4	27·4	24·9	22·8	21·1	19·6	18·2	17·1
340........	31·3	28·2	25·6	23·5	21·7	20·1	18·8	17·6
350........	32·2	29·0	26·4	24·2	22·3	20·7	19·4	18·2
360........	33·2	29·8	27·1	24·9	23·0	21·3	19·9	18·7
370........	34·1	30·6	27·9	25·6	23·6	21·9	20·4	19·2
380........	35·0	31·5	28·7	26·3	24·3	22·5	21·0	19·7
390........	35·9	32·3	29·4	27·0	24·9	23·1	21·5	20·2
400........	36·9	33·2	30·2	27·6	25·5	23·7	22·1	20·8
410........	37·8	34·0	30·9	28·3	26·2	24·3	22·7	21·3
420........	38·7	34·9	31·7	29·0	26·8	24·9	23·2	21·8
430........	39·6	35·7	32·4	29·7	27·5	25·5	23·7	22·3
440........	40·5	36·5	33·2	30·4	28·1	26·1	24·3	22·8
450........	41·4	37·4	34·0	31·1	28·7	26·7	24·8	23·4
460........	42·4	38·2	34·7	31·8	29·4	27·2	25·4	23·9
470........	43·4	39·1	35·4	32·5	30·0	27·8	25·9	24·4
480........	44·2	39·9	36·2	33·1	30·7	28·4	26·5	24·9
490........	45·1	40·7	36·9	33·9	31·3	29·0	27·0	25·4
500........	..	41·5	37·7	34·5	31·9	29·6	27·6	26·0
510........	..	42·3	38·5	35·2	32·6	30·2	28·1	26·5
520........	..	43·2	39·2	35·9	33·2	30·8	28·7	27·0
530........	..	44·1	40·0	36·6	33·9	31·4	29·2	27·5
540........	..	44·9	40·7	37·3	34·5	32·0	29·8	28·0
550........	..	..	41·5	38·0	35·1	32·5	30·3	28·5
560........	..	..	42·2	38·7	35·8	33·1	30·9	29·1
570........	..	..	43·0	39·4	36·4	33·7	31·4	29·6
580........	..	..	43·7	40·1	37·1	34·3	32·0	30·1
590........	..	..	44·5	40·8	37·7	34·9	32·5	30·6
600........	..	..	..	41·4	38·3	35·5	33·1	31·2
610........	..	..	..	42·1	39·0	36·1	33·6	31·7
620........	..	..	..	42·8	39·6	36·7	34·2	32·3
630........	..	..	..	43·5	40·3	37·3	34·7	32·8
640........	..	..	..	44·2	40·9	37·9	35·3	33·4
650........	..	..	..	..	41·5	38·5	35·8	33·9
660........	..	..	..	..	42·2	39·1	36·4	34·3
670........	..	..	..	..	42·8	39·7	36·9	34·9
680........	..	..	..	..	43·5	40·2	37·5	35·4
690........	..	..	..	..	44·1	40·8	38·0	35·9
700........	..	..	..	..	..	41·4	38·6	36·4
710........	..	..	..	..	..	42·0	39·1	36·9
720........	..	..	..	..	..	42·6	39·7	37·4
730........	..	..	..	.	..	43·2	40·2	37·9
740........	..	..	..	..	..	43·8	40·8	38·4
750........	..	..	..	..	..	..	41·3	38·9
760........	..	..	..	..	..	..	41·9	39·4
770........	..	..	..	..	..	..	42·4	40·0
780........	..	..	..	..	..	..	43·0	40·4
790........	..	..	..	..	..	..	43·5	41·0
800........	..	..	..	..	..	..	..	41·5

·20 *per Cent. being included for Stoppage and Loss.*

·85	·90	·95	1·0	1·1	1·2	1·3	1·4	1·5	1·6	1·7	1·8	1·9	2·0
14·6	13·8	13·1	12·4	11·3	10·4	9·6	8·9	8·3	..	..	..	..	..
15·1	14·3	13·5	12·9	11·7	10·7	9·9	9·2	8·6	..	..	..	..	..
15·6	14·7	14·0	13·3	12·1	11·1	10·2	9·5	8·8	..	..	..	..	..
16·1	15·2	14·4	13·7	12·4	11·4	10·5	9·8	9·1	..	..	..	..	..
16·6	15·7	14·8	14·1	12·8	11·8	10·9	10·1	9·4	..	..	..	..	..
17·1	16·1	15·3	14·5	13·2	12·1	11·2	10·4	9·6	9·1	..	..	..	..
17·6	16·6	15·7	14·9	13·5	12·5	11·5	10·7	9·9	9·3	..	..	..	..
18·1	17·0	16·1	15·3	13·9	12·8	11·8	11·0	10·2	9·6	..	..	..	..
18·6	17·5	16·5	15·7	14·3	13·1	12·1	11·3	10·4	9·9	..	..	..	..
19·0	18·0	17·0	16·1	14·6	13·5	12·5	11·6	10·7	10·1	..	..	..	..
19·5	18·4	17·4	16·5	15·0	13·8	12·8	11·9	11·0	10·4	9·7	..	..	..
20·0	18·9	17·8	17·0	15·4	14·2	13·1	12·2	11·3	10·6	10·0	..	..	..
20·5	19·3	18·3	17·4	15·8	14·5	13·4	12·5	11·5	10·9	10·2	..	..	..
21·0	19·8	18·7	17·8	16·2	14·9	13·7	12·8	11·8	11·2	10·4	..	..	..
21·5	20·3	19·1	18·2	16·5	15·2	14·1	13·1	12·1	11·4	10·7	..	..	..
22·0	20·7	19·6	18·6	16·9	15·6	14·4	13·4	12·4	11·7	10·9	10·4	..	..
22·5	21·2	20·0	19·0	17·3	15·9	14·6	13·7	12·6	11·9	11·2	10·6	..	..
23·0	21·6	20·4	19·4	17·7	16·2	14·9	14·0	12·9	12·2	11·4	10·8	..	..
23·5	22·1	20·9	19·8	18·1	16·6	15·3	14·3	13·2	12·5	11·6	11·0	..	..
23·9	22·6	21·3	20·2	18·4	17·0	15·7	14·6	13·5	12·7	11·9	11·3	..	..
24·4	23·0	21·7	20·6	18·8	17·3	16·0	14·9	13·8	13·0	12·1	11·5	10·9	..
24·9	23·5	22·2	21·1	19·2	17·7	16·3	15·2	14·0	13·2	12·4	11·7	11·1	..
25·4	24·0	22·6	21·5	19·6	18·0	16·6	15·5	14·3	13·5	12·6	12·0	11·4	..
25·9	24·4	23·1	21·9	20·0	18·4	17·0	15·8	14·6	13·8	12·8	12·2	11·6	..
26·4	24·9	23·5	22·3	20·3	18·7	17·3	16·1	14·9	14·0	13·1	12·4	11·8	..
26·9	25·4	23·9	22·7	20·7	19·1	17·6	16·4	15·2	14·3	13·3	12·7	12·0	11·4
27·3	25·8	24·4	23·1	21·1	19·4	17·9	16·7	15·4	14·5	13·6	12·9	12·2	11·6
27·9	26·3	24·8	23·5	21·5	19·7	18·2	17·0	15·7	14·8	13·8	13·1	12·4	11·8
28·4	26·7	25·3	23·9	21·9	20·1	18·6	17·3	16·0	15·0	14·1	13·3	12·7	12·0
28·8	27·2	25·7	24·3	22·2	20·4	18·9	17·6	16·3	15·3	14·3	13·6	12·9	12·3
29·3	27·7	26·1	24·7	22·6	20·8	19·2	17·9	16·6	15·6	14·6	13·8	13·1	12·5
29·8	28·1	26·6	25·2	23·0	21·1	19·5	18·2	16·8	15·8	14·8	14·0	13·3	12·7
30·3	28·6	27·0	25·6	23·4	21·5	19·8	18·5	17·1	16·1	15·1	14·3	13·6	12·9
30·8	29·0	27·5	26·0	23·8	21·9	20·1	18·8	17·4	16·4	15·3	14·5	13·8	13·1
31·3	29·5	27·9	26·4	24·1	22·2	20·5	19·1	17·7	16·6	15·6	14·7	14·0	13·3
31·8	30·0	28·3	26·8	24·5	22·6	20·8	19·4	18·0	16·9	15·8	15·0	14·2	13·5
32·3	30·4	28·8	27·2	24·9	22·9	21·1	19·7	18·2	17·1	16·1	15·2	14·4	13·7
32·8	30·9	29·2	27·6	25·3	23·3	21·4	20·0	18·5	17·4	16·3	15·4	14·7	13·9
33·2	31·2	29·7	28·0	25·7	23·6	21·7	20·3	18·8	17·7	16·6	15·6	14·9	14·1
33·7	31·7	30·1	28·4	26·0	23·9	22·1	20·6	19·1	17·9	16·8	15·9	15·1	14·4
34·2	32·2	30·5	28·8	26·4	24·3	22·4	20·9	19·4	18·2	17·1	16·1	15·3	14·6
34·7	32·6	31·0	29·3	26·8	24·6	22·7	21·2	19·6	18·4	17·3	16·3	15·5	14·8
35·2	33·1	31·4	29·7	27·2	25·0	23·0	21·5	19·9	18·7	17·6	16·6	15·8	15·0
35·7	33·5	31·9	30·1	27·6	25·3	23·3	21·8	20·2	19·0	17·8	16·8	16·0	15·2
36·2	34·0	32·3	30·5	27·9	25·6	23·7	22·1	20·5	19·2	18·1	17·0	16·2	15·4
36·7	34·4	32·7	30·9	28·3	26·0	24·0	22·4	20·8	19·5	18·3	17·3	16·4	15·6
37·2	34·9	33·2	31·3	28·7	26·3	24·3	22·7	21·0	19·7	18·6	17·5	16·6	15·8
37·7	35·4	33·6	31·7	29·1	26·7	24·6	23·0	21·3	20·0	18·8	17·7	16·9	16·0
38·2	35·8	34·1	32·2	29·5	27·0	24·9	23·3	21·6	20·3	19·1	17·9	17·1	16·2
38·6	36·3	34·5	32·6	29·8	27·3	25·3	23·6	21·9	20·5	19·3	18·2	17·3	16·4
39·1	36·8	34·9	33·1	30·2	27·7	25·6	23·8	22·2	20·8	19·6	18·4	17·5	16·6

board boss-roller circumference, × boss-wheel, × pulley dia. ÷ revolutions of driving shaft, ÷ drum dia. = spread board speed wheel. Or

$$\frac{90 \times 48 \times 20}{180 \times 12} = 40 \text{ spread board speed wheel.}$$

Vice versa.

$$\frac{780 \times 32 \times 48 \times 20}{2 \times 16 \times 1 \times 8{\cdot}67 \times 180 \times 12} = 40 \text{ spread board speed wheel.}$$

Total inches off spread-board, ÷ total slivers on 1st drawing, × 1st drawing draft, × number of deliveries on 1st drawing, = inches of 1st drawing; ÷ number of deliveries on 1st drawing, ÷ boss-roller circumference, × boss-wheel, × pulley dia. ÷ revolutions of driving shaft, ÷ drum dia. = 1st drawing speed wheel.

Vice versa.

Total inches off 2nd drawing, ÷ 2nd drawing draft, ÷ number of deliveries on 2nd drawing, × total slivers on 2nd drawing, ÷ number of deliveries on 1st drawing, ÷ 1st drawing boss-roller circumference, × boss-wheel, × pulley dia. ÷ revolutions of driving shaft, ÷ drum dia. = 1st drawing speed wheel. Or

$$\frac{780 \times 16 \times 2 \times 63 \times 20}{32 \times 2 \times 7{\cdot}06 \times 180 \times 12} = 32. \text{ 1st drawing speed wheel.}$$

Vice versa.

$$\frac{780 \times 32 \times 63 \times 20}{2 \times 16 \times 2 \times 7{\cdot}06 \times 180 \times 12} = 32. \text{ 1st drawing speed wheel.}$$

Total inches off 1st drawing, ÷ total slivers on 2nd drawing, × 2nd drawing draft, × number of deliveries on 2nd drawing, = inches off 2nd driving; ÷ number of deliveries on 2nd drawing, ÷ 2nd drawing boss-roller circumference, ÷ boss wheel, × pulley dia., ÷ revolutions of drawing shaft, ÷ drum dia., = 2nd drawing speed wheel.

Vice versa.

Total inches off 3rd drawing, ÷ 3rd drawing draft, ÷ number of deliveries on 3rd drawing, × total slivers on 3rd drawing, ÷ number of deliveries on 2nd drawing, ÷ 2nd drawing boss-roller circumference, × boss wheel, × pulley dia., ÷ revolutions of driving shaft, ÷ drum dia., = 2nd drawing speed wheel. Or

$$\frac{780 \times 16 \times 2 \times 63 \times 20}{32 \times 2 \times 6{\cdot}28 \times 180 \times 12} = 36. \text{ 2nd drawing speed wheel.}$$

Vice versa.

$$\frac{1560 \times 48 \times 63 \times 20}{6 \times 16 \times 2 \times 6{\cdot}28 \times 180 \times 12} = 36. \text{ 2nd drawing speed wheel.}$$

Total inches off 2nd drawing, ÷ total slivers on 3rd drawing × 3rd drawing draft, × number of deliveries on 3rd drawing, = inches off 3rd drawing; ÷ number of deliveries on 3rd drawing, ÷ 3rd drawing boss-roller circumference, × boss wheel, × pulley diameter, ÷ revolutions of driving shaft, ÷ drum diameter, = 3rd drawing speed wheel.

Vice versa.

Total inches off roving frame, ÷ roving draft, ÷ number of deliveries on roving, × total slivers on roving, ÷ number of deliveries on 3rd drawing, ÷ 3rd drawing boss-roller circumference, × boss wheel, × pulley diameter, ÷ revolutions of driving shaft, ÷ drum diameter, = 3rd drawing speed wheel. Or

$$\frac{780 \times 16 \times 6 \times 63 \times 22}{48 \times 6 \times 5{\cdot}49 \times 180 \times 12} = 30. \text{ 3rd drawing speed wheel.}$$

Vice versa.

$$\frac{24960 \times 60 \times 63 \times 22}{60 \times 16 \times 6 \times 5{\cdot}49 \times 180 \times 12} = 30. \text{ 3rd drawing speed wheel.}$$

Total inches off 3rd drawing, ÷ total slivers on roving, × roving draft, × number of deliveries on roving, = inches off roving frame.

Vice versa.

Total inches off roving frame, ÷ roving draft, = inches off 3rd drawing. Or

$$\frac{1560 \times 16 \times 60}{60} = 24960 \text{ inches of roving.}$$

Vice versa.

$$\frac{24960}{60} = 1560 \text{ inches off 3rd drawing.}$$

Thus, if a certain speed of spread board be found most suitable for the class of material to be spread over it, it is easy by the preceding rules to speed the system proportionately ; or if it is necessary that a roving frame keep a certain number of spinning spindles supplied, the required speed being found by the preceding rule for "rove cut" ; the proportionate and necessary speed at which its system must be driven is easily calculated as shown above.

As before remarked, there can be no accurate rule laid down for finding the required twist to be put into rove, there being so many contingencies ; but as it is absolutely necessary to have some plan, which will be at least approximately correct, to work by, when a new count of rove is coming forward, so that it may not be twisted either so slack or so tight as to be spoiled, the following is submitted as a safe course to follow :

As the old sort is running out on the roving frame, get one can of the new pieced up at the back, and roved with the doff. This rove on being examined will tell whether the twist wheel on at the time ought to remain, or to be changed for a larger or smaller one as the new count comes to be roved. It will also show whether the index wheel requires alteration, and, if so, how many teeth. Ordinary discrimination will satisfactorily settle these points.

As the calculations for the twist vary slightly from those of the draft, we here give examples by speed and theory.

Twist Calculations.

```
                            200 revolutions of bottom shaft per minute.
                             72 speed wheel.
                          ------
Spindle shaft wheel, 45)14400
                          ------
                            320 speed of spindle shaft.
                             30 spindle shaft bevel
                          ------
      Spindle wheel, 20)9600
                          ------
                            480 speed of spindle.
```

```
      100 revolutions of boss roller, per minute.
     4·71 boss roller circumference.
     ----
      471 inches delivered per minute.
  471)480 speed of spindle.
     ----
     1·02 turns per inch twist.
```

Or

$$\frac{72 \times 30 \times 90}{45 \times 20 \times 45 \times 4\cdot71} = 1\cdot02 \text{ turns per inch twist.}$$

Names.

$$\frac{\text{Speed wheel} \times \text{Spindle shaft bevel} \times \text{Boss-roller wheel.}}{\text{Spindle shaft wheel} \times \text{Spindle wheel} \times \text{Twist wheel} \times \text{Boss-roller circumference.}}$$

Constant Nos. for Draft and Twist. For the speedier calculation of the necessary wheels to give the required drafts or twists, there can be wrought out for each machine a constant or "running number." This is a number that, being divided by the draft or twist, will give for quotient the necessary wheels to give that draft or twist; *vice versa*, if the "constant number" for the draft be divided by the draft wheel on, the quotient will be the draft; and if the "constant number" for the twist, be divided by the twist wheel on, the quotient will be the twist.

These "constant numbers" are found thus: Set down the wheels and pinions and roller diameters just as they are placed in the theoretical arrangement for finding drafts or twists, leaving out the "change" or draft wheel in the draft arrangement and the twist wheel in the twist arrangement—where these wheels are "leaders"—to get the "constant number." Where the wheels are "followers" they must be included, and the draft or twist, as the case may be, must be multiplied by the wheels giving the result in question, to arrive at the "constant number." For example, where the draft or twist wheels are among the "leaders" they are omitted. Thus—

$$\frac{70 \times 80 \times 80 \times 2\text{in.}}{- \times 20 \times 20 \times 2\text{in.}} = 1120. \text{ Const. No. for Draft.}$$

Names.

$$\frac{\text{Back shaft Follower} \times \text{Stud Follower} \times \text{Feed wheel} \times \text{Boss-roller diameter.}}{\text{Draft wheel} \times \text{back shaft leader} \times \text{Stud leader} \times \text{Feed-roller diameter.}}$$

$$\frac{102 \times 28 \times 64}{48 \times 19 \times - \times 5\cdot5\text{in.}} = 36\cdot4. \text{ Const. No. for Twist.}$$

Names.

$$\frac{\text{Boss Wheel} \times \text{Spindle shaft bevel} \times \text{Stud wheel.}}{\text{Spur wheel} \times \text{Spindle wheel} \times \text{Twist wheel} \times \text{Boss-roller circumference.}}$$

When among the "followers" they are included, and used as multipliers, as—

$$\frac{170 \times 72 \times 75 \times 74 \times 1\tfrac{3}{4}\text{in.}}{102 \times 83 \times 25 \times 20 \times 1\tfrac{3}{4}\text{in.}} = \begin{cases} 16\cdot05 \text{ Draft x } 72 \text{ (Draft} = \\ 1155\cdot6 \text{ Const. No. Draft.} \end{cases}$$

Names.

$$\frac{\text{Stud follower} \times \text{Draft wheel} \times \text{Socket follower} \times \text{Feed wheel} \times \text{Boss-roller diameter.}}{\text{Boss wheel} \times \text{Stud leader} \times \text{Back shaft leader} \times \text{socket leader} \times \text{Feed roller diameter.}}$$

Rove Handling and Carrying. Rove should be very carefully handled from the time it is doffed off the roving frame until it is put into the spinning frame "creel." That this may be done it is necessary that each roving frame should be supplied with about 30 or 40 boxes, so constructed as to hold exactly one doff of full-rove bobbins, and shaped so as to sit with ease on the rove-carrier's shoulder. The number of the roving frame to which they belong must be clearly branded or painted on these boxes, and stands, for their reception, erected before or

near their frame. In these stands there should be three divisions, one for the oldest rove, one for the newest, and these separated by one of about twice their size for the boxes full of empty bobbins.

The rove-carrier should be instructed always to carry away the older rove first, for two reasons—because rove is improved by getting time to "come to" after the heat by friction to which it has been subjected in the preparation; and because there is no more likely way in which yarn will become "stripped"—the mixing of sliver or rove excepted—than by rove just doffed being put into spinning frame creels with rove off the same roving frame, but, perhaps, some weeks older. This arises from the fact that different "lots" of flax sometimes are of different shades, and these lots on passing in regular order through the preparing are spun into yarn of different shades of colour. This difference of shade is not perceptible if the preparation be carried on, and spun up, in regular order. Racks must be fitted up in the spinning-room "stands" for the reception of these boxes of rove; one for each side of the spinning frame, and one for the empty bobbins—three in each "stand."

When the rove-carrier sees any of the sorts becoming scarce in the spinning-room he takes up the box full of empty bobbins out of that "stand," and carrying it to the preparing-room from which it came, he there leaves it on a bench, and brings away the sort required. The preparing room doffers must pick and clean these empty bobbins as they are brought from the spinning room; count the number required for the doff into the box; and then leave the latter in its proper place before its own roving frame to be again refilled with rove.

Rove Carting.

This system of handling rove is preferable to the more general one of carting the rove. In the latter, the doffers throw the full rove off the frame into open binns—they cannot be got to build it in properly—which treatment of itself is good for neither the bobbin nor the rove. The rove drawer has then to throw the rove out of these binns into his cart, this taking time; he has then to cart the load—sometimes of many sorts, and nearly certain to be mixed—to the hoist, if the preparing-room happens to be on a different level from the spinning-room; and perhaps there wait some minutes before the hoistman can attend to him. Then he has to lift the rove out of his cart into the place for its reception in the spinning "stands," and to fill his cart with empty bobbins, which he must cart back to the preparing-room, and lift out of his cart on to the bench. Here we have three handlings of the rove where one might do; three throwings of bobbins, to their injury, where there need not be any; and unnecessary wear of floors and hoist, without any advantage to compensate for the resulting evils.

CHAPTER X.

GENERAL REMARKS ON PREPARING.

In the construction of the "gills" of a system or single machine there are many items to be considered. For instance, if a very strong gill be required for coarse work besides a certain number of pins per inch it might at first sight seem essential to have them of very coarse wire. And this is right in so far as that the size of the wire bears a fixed proportion to the number per inch. For if the size be too large in proportion to the number of pins they will lie so close as that there will not be the requisite space between them for the fibre, and as the pins lie close, so must the holes be bored so close together in the stock as to assuredly render it unfit to bear the most ordinary strain without the whole row, and half the stock breaking away.

About Gills.

Close Gills.

Again, it is possible to fall into the opposite extreme and put in too few pins per inch for the size of wire. This gives a poor thin-looking gill that cannot bear the least squeeze or an ordinary load of fibre in it without pins breaking out in dozens, necessitating this class of gill being half time in the hacklesetter's shop for repairs.

Open Gills.

If, in the case supposed, the pins have been ever so little disproportionately long it makes matters doubly worse.

Long Pins.

The contrary mistake and one likely to be prevalent where preparing machinery is scarce, is to have the pins too short. This certainly produces the end aimed at—strong gills ; but if these be at all heavily loaded, as in such a case they are nearly certain to be, much of the fibre is not pinned at all, but gulped in by the rollers, this being productive of a shired and fishy sliver and yarn to match.

Short Pins.

As a guide to the correct proportioning of gills, we take the liberty of placing before our readers the annexed table, compiled by a friend ; this being, so far as we know, the only instance in which we present any table or calculations that are not original.

TABLE OF PREPARING GILLS.

Gill Table.

Wire Gauge.	Pins per Inch.	Length of Pin	Body of Pins per inch.
12's	6	$2\frac{1}{2}$ inch	10 Pins.
13's	7	$2\frac{3}{8}$,,	11 ,,
14's	8	$2\frac{1}{4}$,,	13 ,,
15's	9	$2\frac{1}{8}$,,	14 ,,
16's	10	2 ,,	16 ,,
17's	11	$1\frac{3}{4}$,,	19 ,,
18's	12	$1\frac{5}{8}$,,	22 ,,
19's	13, 14	$1\frac{3}{8}$,,	24 ,,
20's	15, 16	$1\frac{1}{4}$,,	26 ,,
21's	17, 18	$1\frac{1}{8}$,,	28 ,,
22's	19, 20	1 ,,	31 ,,
23's	21, 22, 23	$\frac{7}{8}$,,	34 ,,
24's	24, 25, 26	$\frac{13}{16}$,,	40 ,,
25's	27, 28, 29	$\frac{3}{4}$,,	46 ,,
26's	30, 31, 32, 33	$\frac{5}{8}$,,	52 ,,
27's	34, 35, 36, 37	$\frac{9}{16}$,,	57 ,,
28's	38, 39, 40, 41, 42	$\frac{1}{2}$,,	63 ,,
29's	43, 44, 45, 46, 47	$\frac{7}{16}$,,	70 ,,
30's	48, 49, 50, and upwards	$\frac{3}{8}$,,	78 ,,

Pins range from $\frac{1}{4}$in. to $7\frac{1}{2}$in. in length, and may sometimes exceed even the latter dimension. From $\frac{1}{4}$in. to 2in., the lengths are graduated by eighths of an inch, past that point they ascend by $\frac{1}{4}$in. at a time. The different sizes are known by numbers.

Turned Points.

It is not easy to account for the number of points that are turned or broken in the "gills" as they work in the machine. These turned or broken points not only injure the fibre, but necessitate the more constant cleaning or picking of the gills, as the loose fibres and flowings are more prone to lap round the "faller," where they get holding ground on these turned points. Draughts of air in the room may be looked upon as the chief cause of this evil, thus : The iron jockey-rollers are more liable to lap than the others ; when the lap becomes noticeable from its size, the girl in charge has to get on to the top of the machine, or to get at the roller from behind, to reach the lap ; she has then to lift out the jockey-roller, which, being heavy, she rests on the feed rollers, from which it may slip upon the pin points and so blunt them. Besides this, if it has been carelessly left upon the feed rollers they may have been dinted, or the jockey-roller may have been scored on coming in contact with the pin points ; in all these cases the chances of further and increasing "laps" are doubled. For this reason, when the machines in a preparing room are being cleaned all rollers should be well scoured with powdered and very dry whiting, procured for the purpose. The use of chalk or sand, or emery paper, should be strictly prohibited, as all these are liable to score, and if particles drop in about any "bearings" they may cause them to heat. Whiting cannot be bought sufficiently dry, and so should be placed over the boilers, from whence it can be taken as required without further trouble. Thoroughly dry whiting is also invaluable in preparing, for the "rubbers ;" and to sprinkle sparsely over either flax or tow with a tendency to be damp, that it may draw more freely through the pins, and not be so liable to lick up, and lap.

The Rubbers.

The "rubbers" referred to, are either stocks covered with flannel, and fixed to bear against both boss, feed and pressing rollers, to prevent the passage of the "licking-up" back into the sliver, and to stay the "laps ;" or else they may be bosses covered in a similar manner, and made to revolve. No preparing machinery should be without these revolving rubbers for the boss roller, as by their use any ugly "tails" that would otherwise gather are entirely prevented, to the marked improvement of the sliver ; but the "top rubbers"—or those for pressing and back rollers—are better immovable or "dead." Revolving rubbers so placed are injurious rather than otherwise, as they let the gatherings drop back into the sliver.

Revolving Rubbers.

The prejudice against revolving rubbers, either bottom or top, is very strong ; the trouble they give being said to more than counterbalance any benefit gained. The writer would assign as one, if not the only reason for this trouble, the fact that there are revolving brushes, supplied with the revolving rubbers, to keep them clean. In his opinion these brushes are the sole cause of complaint, as they not only tear open the seams of the flannel covering by their incessant friction, thus causing laps ; but they pass dirt up into the faller besides. Have the revolving rubbers driven dead slow, and there is no necessity for any brush, as the "gathering" becomes "caked" on the flannel, and soon drops off of its own weight ; or at least can very easily be picked off. In this way neither ripping seams nor dirty fallers are produced, but sliver free from impurities is obtained. It cannot be denied, however, that with every precaution these revolving rubbers are troublesome to keep in order, as if a lap gets on, and is allowed to run, until it becomes hard, it indents the flannel of the boss, so

that that "head" of rubbers must be taken out and the boss be re-covered before it is again fit for work. But where matters are so arranged that any one head of rubbers can be taken out, by the slipping over of a "cap," and lifting out that length and replacing it in the interim with a spare rod, so that the connection may not be broken, there is no time lost; and the mere keeping of the rubbers of say 30 systems in perfect order could be accomplished by one apprentice mechanic, who devoted his time to it.

Disablements. If, as is unfortunately generally the case, these revolving rubbers are not constructed to lift out with ease, when a boss is so spoiled, as that it won't keep the frame from gathering "laps;" the best plan is to run the slivers of that row over the rows next to it until it is convenient to stop the frame for repairs. This course is often followed where a "yew" is broken;" pressing rollers scarce; a row of gills smashed; a spring wire broken; or some such cause exists: but it is scarcely necessary to remark that the seldomer the adjoining gills are so over-loaded the better. To give bottom revolving rubbers a fair chance, there should be strict prohibition of anything, such as flax, etc., being lapped round any boss not working well; as the attempt to thus set one boss right, is likely to make many others wrong. In renewing the flannel care should be taken to use only that of the same thickness as before employed, and also that the sewing of the seam be level and free from inequalities.

Mounting Frames. After this digression we return to the subject of turned pin points. Another but more easily detected cause for this is, boys getting upon the machines with their boots on, for the purpose of oiling; or to pass a belt over the driving shaft; or to prepare the frame for the cleaners; or some such reason. The heels of their shoes strike the pins and blunt the points. The best remedy for this is to give them *carte-blanche* to rest heels—but the natural, not the artificial ones—on the gills as often as desired.

Reference was made above to "cleaning frames."

On Cleaning The best system to adopt, if there be no regular staff of cleaners, is to take twice the number of spreaders from the spread boards, that there are "heads" in the frame to be cleaned. Suppose it is a drawing frame of three heads; for this let there be six spreaders. They break the ends down at the back of the frame, and put the cans carefully to one side, so that they may not be mixed with others. The "ends" must then be run through, and the "fallers" lifted out, and deposited on rests in some part of the room where the light is good. All the fallers being out, the six girls can start to clean them, one to pick and one to clean for each "head." During this time, when the frame is free from confusion, the "drawer" who minds it can get out the pressing rollers and take them to the lathe to be slid, in her spare moments. After the fallers have all been got out, it is advisable to throw off the driving belt from the drum, before the girls are allowed to commence cleaning; as the belt, if running, might be turned through carelessness on to the fast pulley, and if any of the cleaners happened at the moment to be working about the gearing there might be fingers or a hand taken off.

The "set boy," who should attend the cleaners, after he has knocked off the belt, can take off all covers, stud and intermediate wheels, and conductor bars; and lift out the back rollers, and so clear the way for the cleaners.

Examination of Fallers. When the "fallers" have been properly cleaned, the "hackle setter" must go over them, straightening up all bent points, and, if necessary, picking out some of the worst fallers for more perfect repairs. During this examination the girls are cleaning the frame, one at the front and one at the back of each "head."

The "conductor bars" and back rollers being out of the way, the cleaners can get their pickers thoroughly in about the "tappets" and "screw blocks," and about the screws themselves. They can also pick and clean the gearing; studs; roller seats; and the back and bottom shafting. By the time all this is properly done the "hackle setter" will have completed his examination of the "fallers," which can now be carried back and put in the frame. Care must be taken that none of the fallers be put into the frame the wrong way, as if this be done they cannot possibly drop down on to the bottom slide, but are certain to stick and to be either broken themselves, or break something else, if the frame be not slack in "gear." Besides, these reversed fallers are generally not noticed until the "ends" are all relaid, and the trouble of getting the frame into working order well-nigh ended; when the whole has to be undone to get the faller out.

Nothing but practice will fully post up the learner in the many short cuts that can be taken about a frame, in the matter of either stripping it of stuff; or detecting by aid of the gearing what portion has gone out of order or become jambed. The disconnecting of particular trains of gearing by taking away certain "intermediate wheels," etc., is the means used to expedite these matters.

After the fallers are properly in, and the different parts of the machine put together again by the boy in attendance, who must see that no screws, washers, etc., are missing; the next item is to oil the different parts thoroughly. This must be done carefully from a long and fine pointed oil can, as if drops fall upon the gills or rollers the sliver will be sure to stick and lap at these parts, and to a great extent nullify the advantage gained by the careful cleaning. The application of too much oil is as injurious as too little, if not more so, for the self-same reason.

It will suffice to give frames such a thorough cleaning as here spoken of once every two to four months, that is if the fallers have been cleaned six or eight times in the interval, and all parts of the machine regularly and properly oiled.

Exactly the same remarks are applicable to the cleaning of the roving frame, except that in this case there should be an extra hand over and above the two to each head, this one being appointed to clean and pick the differential motion, racks, and bottom gearing, and to leave the whole underneath part of the roving frame perfectly clean. The "bringing through" of the "ends," above commented on, after the fallers are in, is accomplished thus: The slivers out of the cans at the back are put over their pulleys, and taken together in the hand, to the number it is requisite to put over each jockey-roller; these are put through their respective back conductors, and passed up between the back roller and the "jockey," over the latter, and down between it and the feed roller. The bundle of "ends" is then slipped up between this feed roller and the fallers, when a girl in front takes hold of them and pulls the whole, together, until they are separated into their proper positions on their jockey-roller, and over their particular rows of gills. The slivers for each gill must then be pulled separately, to take away the tossed end, and then let fall evenly upon the gill, terminating in a point, which may be compressed into the pins to ensure the fibre passing into the conductor, instead of outside it, on the fallers carrying it forward. If, from careless "laying," some of the ends do happen to fall foul of the front conductor, there is much time lost, and waste made, in the relaying the sliver and getting it again through its conductor.

Cleaning the Roving Frame.

The drawing of the slivers into position in this manner, before starting the frame, tends to prevent the spoiling of the newly-slid pressing rollers.

Laying the Ends.

If the sliver be uneven on the jockey-rollers from any cause—as from the raising of one end of the roller to pass in a

"dropped end" or to cut off a lap, and the lowering of this end of the jockey-roller into its place again—it is disordered and drawn in just in proportion to the height to which the roller was raised. These graduated "loops" cannot be drawn back in a body, as the tightening of the larger would strain the smaller; nor can they be pulled back singly, for if the "backminder" were willing to devote time to this occupation she, in nine cases out of ten, could not accomplish it, as the toes of the back conductors catch the sliver, and sadly tear it if it be pulled against them. So the "loops" of sliver in the jockey-rollers are delivered into the gills and drawn out in thick parts or lumps, perhaps in the meantime spoiling or choking the roller as well as damaging the sliver, and this can be traced to causes not unavoidable. Another evil attends laps on the back rollers, which is, that the displacement of the jockey-roller takes away the retard from all the slivers but those in contact with the lap; this allows the others to be carried in by the lead of the faller, causing them to be improperly pinned and to produce sliver much heavier than is correct. Odd slivers passing over any jockey-roller tend to the same result, therefore where it is necessary to have an uneven number of cans in the "set," it is quite as important to take the length of the jockey-roller into consideration, as it is to balance the "pressing rollers."

Brushing Out.

In addition to that of cleaning, preparing machinery must frequently undergo the process of "brushing out." This is the brushing away of all dust and flowings from about the machinery, and is an operation that requires to be performed from once to four times a day according to the class of material that is being prepared. The girl should stop the frame before she commences to brush out; and when she has finished, she should run all the sliver that may have become tossed or dirtied to the floor, and pull it carefully into sliver waste, instead of letting it run into the cans.

This system may appear to some the height of extravagance, and an unnecessary loss of time besides; but it is not so. It is the only method of ensuring full justice being done to the material; for where the girls are permitted to use their brushes on machinery in motion, they care not how they fray and toss the sliver as it passes out of sight into the can. In fact, no matter how careful they may be, they could not use the brush without injuring the sliver, when in motion. Whereas, if every precaution be taken to ensure care for the material, the workers will soon learn the necessity of practising equal and unremitting attention, not only in this particular, but in every other.

Care of Sliver.

Another step in the same direction—regard for the sliver—is to have all sliver cans as large as is consistent with room for them under their respective sliver pulleys at the back of each frame. The reason for this is that where the cans are small it is next to impossible to prevent the sliver overflowing and falling to the floor, where it is sure to contract dirt; and to be tossed in the "sliping" back into the can.

Where the sliver is heavy and stiff, and the cans on the small side, the insertion of a "tongue dish" into the mouth of the can will, to some extent, prevent the overflow. But this remedy has serious disadvantages, as the sliver is more crushed, and very liable to entangle on being pushed down from the more extensive area of the dish into the confined space of the can. Sometimes the sliver will overflow for a few yards only, and then pass again into the can. The proper thing to do in this case is not—as careless drawers do—to lift the portion that has overflowed and put it into the can over the rest; but to take out the whole from the part where the overflow commenced, and "slipe" all back again into the can. If this be not done, there is every probability of the sliver being dragged and

broken, when the can is emptied as far as this entangled part, on going up at the back of the succeeding frame; or else of its passing into the gills double or treble fold. The former occurrence is the chief origin of the longest running case of "singling;" and the latter of the worst type of "squeeze."

Emptying Cans. Sliver cans should not be lifted for the purpose of emptying sliver out of them, as the manner in which this is done is very destructive to the cans, and often to the sliver pulleys on the back rails; at the same time being injurious to the sliver itself. The girl catches the can in her right hand and swings it up into her left arm. She then attempts to take hold of the sliver at the bottom of the can; but cannot, as her arm is shorter than the can; and the sliver is tightly pressed into the bottom of the latter. To get at it she batters the bottom of the can against any resisting medium; as the top of another can; the sliver pulleys; or a doubling plate; bruising and damaging each or all of these articles. In the case of the sliver pulleys, their broken and serrated edges incessantly tear and cause to lap—all sliver passing over them. However, this emptying of cans is only likely to occur if there is an insufficient number of spare cans; or too much sliver accumulated at the backs of the frames.

Proper Speeding. It should be a rule, therefore, to drive preparing machinery as slowly as is consistent with the keeping up of a moderate stock of "rove"—say for three days—full allowance being made for necessary stoppage for "brushing out," and for cleaning days.

But care must be taken not to keep the sliver stock over a system too low, as this gives rise to the evil of much piecing: A back-minder sees an end passing through the back conductor; she has no spare can of sliver doffed and to hand to piece up, so, to prevent the end passing

Bad Piecings. in and thus necessitating much trouble in passing another in over the back rollers, she breaks off an end from another of the slivers as it passes in and pieces it to the one just disappearing. This hastily pieced end will produce either a "shire" or a lump; if it does not break entirely at the front and run to the floor, perhaps for some time, before the drawer detects it. The broken sliver has also to be pieced afresh. Thus we have, say three piecings where one might suffice, from the cans not being more than one-third filled before they have to be doffed; and this multiplied by two piecings, one of which is sure to be very bad, makes in all six piecings, where one would have sufficed if the sliver had not been so low over the system.

On Oiling. Before passing from the subject of cleaning and oiling preparing machinery, it may be well to state that there are different opinions as to the best method of oiling. Some consider it can best be done by the girls themselves; with the exception of the faller-ends, screw-blocks, and shafting and gearing, which should be done at stated intervals by the "roller-boy." Others think that there should be one person made responsible for the oiling of all parts of the machinery.

In the former case a sufficient allowance of oil of average quality, say olive and sperm, or lard and mineral mixed, is for coarse and medium frames—one-and-a-half glasses for each spread board; one glass per "head" for each drawing-frame; and two-and-a-half glasses for each roving-frame, per day. And for fine frames—one glass for each spread board; half a glass per "head" for each drawing frame; and-two glasses for each roving frame.

Where the entire oiling is in the hands of an oiler, the best arrangement is for him to commence with the spread-board journals the first thing after each start, and take all the journals in the room. Then he should take the "necks" of the roving-frames, then the "hangers," all of which must be done at least three times a day, and more frequently if possible; all "guide"

and slack pulleys, bottom-shafts, and arbour "washers" once a day: and the back shafts, screw-blocks, faller-ends, and spindle "steps" twice a week. If this system be carried out thoroughly, the saving of both oil and wear and tear of machinery will be great; as the girls often use the oil that should go on to the machinery for washing their hands, oiling their hair, etc.

With some boys it will be quite safe to pay a bonus on all oil saved over the complement, so that they may economise in every way as far as is admissible. In the case of the journals it is very advantageous to fasten lengths of thick flannel cloth inside the covers, and instead of pouring the oil on the journals to pour it on this flannel, from which it will trickle down to the journal as it is required. A still further improvement may be effected by entirely filling up any available space in this cover, and behind the journal, with tallow; which will remain long enough, and exclude all impurities from the journal; that is, if it be not already scored and cut up. In this case the heat engendered by friction would fast melt the tallow and lubricate the abrading surfaces.

On Repairs.

We shall now mention the portions of preparing machinery that first show signs of wear, and which require frequent renewal or repair. The boss-roller requires to be frequently "lined up;" and at longer intervals to be turned up in the lathe. This insures a good level preparation, with the minimum consumption of timber for pressing-rollers. New brasses will be required for the bottom and back shafts, and journals. New tappets; slids pierced at the ends; and very frequently new conductors; arbours; arbour nuts; and sometimes the screw-plates bushed. Also odd portions of new gearing; and a few studs. All these remarks apply also to the roving-frame, with the addition of new brasses and bushes about the differential motion and cones. The builder motion and link may require to be tightened up; and new brasses provided for the bobbin and spindle shafts; and new steps and necks. If these latter be not kept in good order the spindle blade will become badly worn by the vibration and consequent abrading between it and the bobbin, especially if the latter be too large for the blade. There has recently been introduced by Hattersley, of Leeds, a new arrangement of the flyer on the spindle top; the objects aimed at being durability, and to prevent its being dragged off the spindle by lapped or twisted rove. This patent is called the "Lock-top," and the writer, after proving its working for years, can pronounce it to be all that could be desired. Although the flyer is of steel, rendering it quite as strong, though much lighter, than the more top-heavy one of iron; yet it and the spindle can be procured at a moderate cost—the former being, for the coarsest roving frames, about 4s. 6d.; and the latter about 3s. each. Of course old spindles can be re-topped for the new flyer, at small cost, if required.

Lock-top Spindle.

A full description of the flyer and the spindle we will extract from an article that appeared in the *Textile Manufacturer* some time ago: "In order to allow of easily and rapidly doffing the flyers in roving-frames, the plan hitherto in use has been to cut a short longitudinal groove or keyway on the top of the spindle, and to insert in the socket of the flyer a straight feather or rib, which, when the flyer is put on the spindle, slides into the groove. This method, while it attains the object aimed at, does so at the expense of many serious practical disadvantages. For instance, it is no uncommon occurrence for the key to be completely sheared through by the jerks due to the frequent startings and stoppages of the spindles for picking up the roving or sliver; and furthermore, should the roving happen to get entangled before it reaches the bobbin, the flyer may sometimes be fairly lifted off the spindle—doffing itself, in fact, while revolving—with the result of getting projected amongst the other flyers, doing serious injury to them and other parts of the machinery. What is required is a simple and inexpensive

method of fitting the flyer to the top of the spindle, which allows the same facility of doffing as the ordinary plan, but which must effectually *lock* the flyer to the spindle when the latter is revolving and the former is doing its work. Many attempts, we believe, have been made from time to time to attain this very desirable end, but for some reason—probably the cost of manufacture and maintenance in repair—they have not been permanently adopted. We therefore think this device for providing a 'Lock-top,' by which all *desiderata* seem to be satisfied, is worthy of the notice of those who have experienced the inconveniences attendant on the use of the common mode of attachment. The top of the spindle has a peculiarly shaped groove made in it, rounded at the bottom, and passing in an approximately spiral form round the spindle. The groove is intended to receive a small rounded button or stud rivetted inside the socket of the flyer. . . . When the flyer is placed over the spindle top the button enters the groove with the greatest facility, and, on account of the screw-like action of the contrivance, the greater resistance the flyer meets with the more is the tendency to secure it increased. Unlike a screw, however, the locking is such that no difficulty is experienced in separating the parts. Manufacturers who use it acknowledge that it meets every requirement for efficiency, and not the least that can be claimed for it is the inexpensiveness of the fittings in the parts."

Cause of Ravelled Rove.

If the spindles sink much in their steps, or the wharves upon their collars, unevenly-built rove will be the consequence. This may be easily remedied by getting a number of brass rings cast, of from $\frac{1}{32}$nd to $\frac{3}{16}$th of an inch in thickness, large enough to pass down over the neck of the spindle and to rest on its collar, so raising the wharf to any required level. On no account must these rings be used until they are well glazed and free from sand, as this would soon injure all before it. The spindles can be easily lined up by reaming out the steps of those that stand highest; and the builder can then be re-set to the flyer eye.

Travelling of Boss-roller.

If the boss rollers of preparing machinery be not very level in their seats, the great pressure on them will cause a wearing or "travelling" laterally, to the lower side. This is exceedingly injurious to the preparation from the gradual displacement of the worn by the unworn—or, as will be understood from reference to our previous remarks on "friction" between wood and iron, by a too much worn—portion of the roller. The evil is especially great where there are slightly raised bosses on the boss roller, as in some cases the edge of these bosses will have come within the conductor space before it is attended to. This travelling can be easily prevented by the tightening of a collar on the ends of the boss roller where it passes through the gable or bracket. Where the preparing is kept in good order, and the rollers regularly "lined up" and "skimmed," this travelling cannot get to any head.

Repairs *v.* Weight of Set.

This reducing of the size of the rollers by "skimming," if it were practised upon both boss roller and feed roller at the same time, would not affect the weight of the rove. But the boss roller will be skimmed many times for the feed roller's once; consequently, when this is the case it is well to reduce the weight of the "set" proportionately to the amount skimmed off—if a 64th, a 64th part less in set, etc.

For those not versed in the rule of simple proportion there can be a standing or "constant" number for the set. This is the pounds in set multiplied by the yards per ounce that that weight produces: as, if a 30lb. set produces rove 100 yds. per ounce, 3,000 is the constant number. To find the required pounds in set, to produce certain yards per ounce over that system, the required yards must be divided into the constant number.

To return from this slight digression, the skimming of the boss-roller may give too much "lead" on the "delivering roller," in which case the latter can be reduced in speed one tooth or so. The skimming of

Lead of Faller.

the feed-roller may give too much lead to the faller, in which case, though troublesome, it may be necessary to reduce the speed of the screw. The "lead of faller" is found by dividing the speed of the screw, multiplied by its pitch per inch, by the speed of the feed-roller multiplied by its circumference. The "speed of the faller" is found by dividing the revolutions of the spiral screw by its pitch.

Pitch of Screw.

This "pitch of screw" is an all important feature in preparing, as the finer the pitch, the closer can the fallers be got together; and therefore the less becomes the space between the "nip" of the boss-roller and the gill; a matter of great importance where the material to be prepared is of fine or short staple. But close fallers imply narrow ones, which is equivalent to weak ones, unless the faller be shortened proportionately.

Length of Faller.

Again, fallers, for their own preservation, and that of the rollers, and to work satisfactorily, must have a certain rigidity, dependent upon the relationship between their length and the pitch of screw. A faller 16in. long will be rigid enough to work to the very finest pitch of screw, say $\frac{1}{8}$in. Proportionately, the length of faller may be increased 2in. for each 16th of an inch on the pitch. Thus, if $\frac{1}{8}$in. pitch is 16in. faller, $\frac{3}{16}$in. pitch may be 18in. faller, $\frac{1}{4}$in. pitch 20in. faller, etc.

Breadth of Gill.

Pitch of Boss.

Then the proper "pitch of screw" is dependent upon the "breadth of gill," which, as before shown, is dependent upon the "coarseness of the lea." In this manner can all the parts of a machine be proportioned from the coarsest count to be wrought over that machine; and even the "pitch of boss" is also regulated by the breadth of gill, thus:—the breadth of gill, multiplied by 1·7, will give a pitch of boss that will reduce to a minimum the friction caused by too open spacing or too much crowding. Again, the breadth of gill, divided by five, will give the proper pitch of screw. Then the length of faller—dependent on the pitch of screw,—divided by the pitch of boss, will give the bosses per head, and one over for screw clearance. Thus 18in. faller ÷ 2in. pitch of boss = 8 bosses per head, the remainder for screw clearance, etc. Roving frames must have a pitch of boss to suit the breadth of flyer.

Avoidable Friction.

The pitch of boss, being proportionate to the breadth of gill, will reduce to a minimum the heating of the pressing rollers, from the increased leverage necessary, if the spacing between the bosses be excessive; or from the friction engendered between the hanger and the bosses, if the spacing be too limited. This latter friction will be greatly augmented by the accumulation of waste about the arbour, which cannot be removed until the roller be taken out. Then, if the wood of which the bosses is made be not thoroughly seasoned, the heat from the friction referred to soon splits and loosens the boss upon the arbour, which causes still greater waste, laps, damage, and confusion. The evil has a tendency to extend itself, *e.g.*, the disabled rollers are returned to the wood-turner to be renewed, giving him increased work, and at the same time consuming an undue and extravagant

Waste of Timber.

quantity of timber. Thus matters daily grow worse until every spare arbour, and most probably some which cannot be spared, have to be sent down daily to the wood-turner's shop, to be refilled. These, being repaired with unseasoned or green wood, work only a very short time in their frames until they become spoiled, require to be taken out and re-slid, and this goes on until a roller which, if it had been

made of seasoned wood, might have lasted six months, is slid away inside six weeks. Thus, besides the waste of timber, we have greatly increased waste of material in the preparing department; loss of turn-off; and loss of the preparer's and roller-boy's time; this, perchance due to the omission of necessary oiling, etc. And this acme of disorder and mismanagement is traceable to badly designed, badly conditioned, and overdriven machinery; coupled with overloaded gills and unseasoned timber.

A Room in Disorder.

Skin on Pressing-Rollers.

Even with thoroughly seasoned bosses, the pressing-roller does not come to its proper way of working for an hour or so after being screwed-up in the frame, as it takes time to mould the surface to the peculiarities of its bed, and to harden it by the pressure. When "skin" has thus been got upon the roller it is desirable to preserve it as far as possible; therefore if the slightest indentation be noticeable in the surface, the best course is to stop the frame at once, take out the roller and have it brought to the lathe and sand papered. There is not the least necessity to apply the cutter to a roller thus taken in time, as this would only remove that very part which forms its protection—the compressed surface. The outside of the timber is of itself hardest and best, the nearer to the heart the more open and soft it becomes, and the more susceptible to damage from the increased friction arising from the greater number of revolutions made by the roller of smaller diameter. Consequently unless where a roller is spoiled, and therefore requires sliding, it is quite sufficient to true-up all the pressing-rollers of a preparing room once every week or two, according to circumstances. This can be done when the fallers are being cleaned; or on Saturdays when the frames are being brushed-out, and the room is receiving its weekly cleansing.

Sliding Rollers.

Burnishing Rollers.

Coating Roller Sides.

In some establishments after the pressing-rollers are sand papered they are burnished with a hard substance, their surface having first been rubbed with a concoction of raw linseed oil and turpentine. The tendency of the bosses to split or skelf will be materially lessened by their sides being coated with a varnish composed of one-third white resin and two-thirds shellac, dissolved by heat in spirits of wine. This should be applied by the wood-turner before the roller leaves his hands. Sometimes pure red lead paint is applied instead.

Washing Rollers.

Where the surface of the pressing-roller shows a tendency to gather a gummy sort of substance, as is especially the case when some kinds of Continental flax are being prepared; a very efficacious wash that may be applied with a patch of waste, as the roller revolves in its frame, and without any chance of damage to the sliver, is made by mixing half a pint of raw linseed oil; one noggen of turpentine; one pound of powdered chalk or whiting; and a very small quantity of soda, in one quart of hot water. Where such a wash is not procurable, the girls resort to the use of oil in cleaning their rollers; but this practice is very prejudicial to the preparation and should not be permitted.

Wood for Rollers.

The most suitable wood for preparing pressing-rollers is alder; it retains the smoothest and most even surface, without becoming hard and unyielding, and then, in time, breaking off in skelfs. Mahogany, black birch, sycamore, elm, boxwood, elder and beech are also used for this purpose. Leather covered bosses used to be much in vogue for coarse numbers, and with over-loaded gills.

In badly regulated preparing rooms, machines may frequently be seen lying idle for want of pressing-rollers. There should be no reason nor excuse for this state of affairs; there being always a spare arbour

Stopped Machinery.

supplied with each head, by the machine makers. If the overlooker sees that no arbours are burned in their centres, from want of greasing when put in the lathe; that none are lost through carelessness; nor left lying in the room when they should be down with the wood-turner to be refilled; and that the latter keeps his work up; he can and should make it very unpleasant for the roller-boy to keep frames stopped for want of rollers.

Burned Centres.

Roller-boy's Work.

This boy besides keeping up his stock of spare rollers, should also be trained to go round the room every hour or two and gather up all those rollers that have been taken out to be sand papered, and after dressing them he should bring them back to their own frames. This system will prevent groups of girls standing round the lathe waiting for rollers to be slid; an errand which they make in many instances an excuse for a lengthened chat among themselves; when most likely singling is being made; cans are overflowing; gills being smashed; or any of those numerous misadventures happen that are surest to occur when the attention of the attendant is drawn, even for two minutes, from her "stand."

Cause of Scarcity of Rollers.

An apparently trivial, but really great, evil in a preparing room is the burning of the arbour centres, above referred to; and the lathe centres; by careless roller-boys. These boys are not always careful to stick a small piece of tallow in the countersunk hole in the arbour ends, before putting the roller into the lathe. The velocity, and tight screwing up, soon cause the roller ends and the lathe centre-bit to heat, and then, for want of lubrication, to burn. This burning is simply the grinding away of the metal, and consequently involves the destruction of the true centres of both arbour ends and centre-bit; this rendering it impossible for the roller to be truly slid; so that, when screwed up in its frame it has a slightly excentric motion, which is very productive of nipped or fished sliver, and spoiled rollers.

The roller-boy, from fear of consequences will not inform the overlooker of his lathe centre-bit being burned; and so it remains in use, making the burnt arbour ends infinitely worse; so bad indeed, in many cases, that the arbour becomes worthless, and the boy makes away with it, to escape detection. This throwing away of spoiled arbours is the chief cause of the remarkable scarcity and mysterious disappearance of pressing-rollers, that oftentimes so mars the successful working of a preparing room. Worse still, the damaged lathe centre-bit is slowly but surely putting every arbour centre in the room astray. This state of affairs continues until the overlooker learns to look more closely after his roller boy; and has started him anew with arbours and centre-bits which have been overhauled by being softened; re-centred; case-hardened; and repolished in the mechanic shop; and with the full complement of spare arbours, besides. All this is done at no small outlay, and suggests the advisability of guarding against its recurrence.

Charge of Rollers.

To prevent such occurrences, there is in many concerns one steady responsible man, at good wages, who is appointed to take charge of the sliding and burnishing of the pressing-rollers for all the preparing machinery. The only objection to this arrangement is the greater distance to which the rollers must of necessity be carried, as there is in this case only one lathe for all the preparing rooms; whereas with roller-boys, there should be a lathe in each room. However this slight objection is more than counterbalanced by the great saving of timber consequent upon careful sliding, if there were no other considerations.

It is advisable to make the arbour nuts or washers of brass; if it be an understood thing between manager and overlooker that no roller is ever to be put into the "yews" without them. If the washers be of brass they will not wear the arbour ends as iron ones do, and the cost of new brass washers is small when compared with that of new arbours. No doubt these small brass articles place temptation in the way of persons addicted to pilfering, but the overlooker can have no difficulty in holding each girl responsible for the full number in her charge.

Washers.

We have seen preparing rooms gone so much to the bad in this respect, that we believe there were not washers to cover the one fourth of the arbour ends; the consequence being, that, in many instances the yew-bars were worn quite through, and required either new bars, or the dove-tailing in of a new piece the next time the machine was undergoing repairs. In rooms of this sort, neither would there be the complement of hand-brushes; nor in fact of anything portable. Where such a lamentable state of disorder exists, the first thing to be done is to get the room supplied with the full complement of everything necessary, and then to hold the overlooker responsible. He can then keep himself safe by warning each of the girls that as she finds her "stand," so she must keep it. Then, on one of these hands being dismissed, the overlooker should minutely examine her frames and stand, to make sure that there is nothing missing. In case of any deficiency he should enter an equivalent fine on the girl's "lines," before handing them to her, and then immediately make good the missing articles, so that the incoming girl may start on a clear footing.

Scarcity of Washers.

Looking after Details.

Dismissal of Hands.

As anything becomes broken or worn out, it should at once be rectified or replaced by a new one; care being taken that the discarded article be not again forthcoming.

Breakages, Etc.

An evil to be specially guarded against in preparing rooms where the preparation is very light over the doubling-plates, or where the dressed line has not been properly cut and dressed, is the licking or lapping of portions of the sliver round the pressing and calender rollers. This evil is especially prevalent during frosty weather, or when there is excessive heat.

Licking-up.

In the case of frost one of the surest preventives is to heat up the machine to a normal temperature, either by placing buckets of hot water under the frame, or by throwing hot water over the floor. The moisture diffused through the atmosphere by this means, instead of tending, as some might suppose to increase the licking-up, prevents it. A simple way of proving this is to breathe upon the surface showing a tendency to lick-up, and the moisture thus produced—or even that from the hand when held against it—will for the moment cause a cessation of the evil. If the calender rollers are too heavy they are more likely to lick-up; they should only be heavy enough to run out the sliver evenly, without pressing too much on it.

Excessive heat also produces licking-up. This may arise from the machine being exposed to the sun's rays, or from its being in too close proximity to the steam piping used for heating the room. In the former case the remedy is to have all windows provided with blinds—indeed no window in a spinning mill should be without them. If the frame be too near the steam piping, the latter can be made to effect a cure by having the finest possible holes bored at intervals in its upper surface. From these fine squirts of steam escape which, on condensing, cool and soften the surrounding air. If the steam piping be judiciously placed through the room,

and if the watchman be enjoined to keep up the same temperature during the night as has been during the day, say 60° Fah., there will be almost entire freedom from licking-up, unless under exceptional circumstances.

Glass Roofs. For the sake of good light and other advantages, preparing rooms are often placed on the ground floor and glass roofed ; but this has generally been found to be a great mistake, as in such circumstances they become too hot in summer and too cold in winter. Whitewashing the glass and slates in summer-time will tend to exclude many of the solar rays, and a very durable wash is produced by slaking the lime with buttermilk, and melting in a small quantity of tallow with the putty at the same time. During frost the moisture in the atmosphere of the room condenses at night, and freezes on the glass, sills, joists, etc. ; the heat from the gas in the morning after starting soon melts all this, and down it comes in countless drops on machinery, into cans, on flax, etc., injuring the machinery, and being the cause of endless squeezes, waste, disorder, and loss of time and turn-off. To keep out the frost is the only remedy in such a case.

Sliver Cans. The cans for containing the sliver are either circular or oval, the former are preferable. They should be as deep as is consonant with their passing under the delivery-roller. They may be made of either sheet iron, zinc, or tin; the last being preferable. Three-joint cans of the best charcoal tin, with the binder wired on the upper side, and put together with resin, or "Baker's Fluid" and solder, are sound cans. If spirits of wine be used it is certainly cheaper than the fluid or resin, but it will not cause the solder to flow so freely and bind as well, as do the latter ; besides it causes rust to show up in a short time at all the seams.

Ten sheets of tin are sufficient to make a 12in. diameter by 40in. deep can ; and, as the best charcoal tin is all sized to a gauge, the weight of such a can will be within a few ounces of $17\frac{1}{2}$ pounds. Eight and a half sheets of the same quality will make a 10in. × 40in. can. Sheet iron and zinc cans have the disadvantage of not being repaired with the same facility as tin ones. They are coated with a lead solution that does not take the solder well ; they have consequently to be rivetted, and the rivets soon give out. These cans are, however, cheaper than those made of tin, not only as regards the material, but from the fact that a man and a boy can turn out as many as eighteen of them in a day, whilst they can only produce a dozen of the tin ones.

The price and weight of the range of sliver cans, of best charcoal tin, will be approximately as follows :—

Cylindrical Can, 40in. deep by	5in.,	6in.,	7in.,	8in.,	9in.,	10in.,	11in.,	12in.,	13in.	diameter.
	2/8	2/10	3/-	3/3	3/6	3/10	4/3	4/8	5/6	each can.
	$6\frac{1}{2}$	8	$9\frac{1}{2}$	11	$12\frac{1}{2}$	14	16	18	20	lbs. weight.

There should only be one size and weight of can at each machine ; of course graduated from the largest cans for the sets, to the smallest at the roving frame back, just in proportion to the body of sliver and the available space at the back of the frames. Attention to this matter will facilitate the correct taking of the sliver stock periodically.

Taking Stock. Stock-taking is important, not only as giving a knowledge of the extent and value of the material in preparation, but for ascertaining the total average waste made in the establishment since the previous estimates. This is all the more important when it be considered, that, in so far as the sliver and rove stock be under or over estimated, so will the average waste for the period be, erroneously, shown as in excess of, or less than, the actual percentage.

There are various methods of taking stock. Some take it correctly once, by weighing each can, and subtracting the average weight of empty can of similar size to get the actual weight of sliver; they then carefully note the general appearance of the "backs," and gauge their succeeding stocks by comparison with this one correctly estimated. Serious errors are liable to occur where this plan is adopted, as in case of fibrous material, weight cannot be estimated from bulk. If the fibre be sound and good it will go into about half the bulk that it will if it be harsh and "fosey." Another method of taking stock is to go round the backs with a spring-balance and selecting from the rest a can of fair average fulness, to find the nett weight of sliver in it, multiplying this by the number of cans, odd included, that are at that back; which gives the stock at that frame. This method, like the former, cannot be depended on to give correct results. The only absolutely correct way of taking stock is to run out the old stock all over the room, and to keep count of the amount of new stock put up, and brought forward. This is easily accomplished where there is a correct system of keeping the "Set Book." This is a small book into which every set is entered in the following manner, as it is put up at the set frame:—

Correct Stock.

The Set Book.

Sets, Week ending 4th August, 1883.

No. of System.	Lea.	Pounds in Set.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Total Sets.	Total lb.
1	40's 2	280	1	1	..	1	..	1	4	1120
2	60's 3	200	..	1	1	..	..	1	3	600
3	60's 4	210	..	1	..	1	1	1	4	840
4	55's 1	210	1	1	1	..	1	1	5	1050
5	50's 1	230	1	..	1	1	1	1	5	1150
6	70's 2	180	..	1	1	1	..	..	3	540
7	80's 3	180	1	..	1	..	1	1	4	720
8	80's 1	160	..	1	1	1	1	..	4	640
	495	1650	4	6	6	5	5	6	32	6660
	Avg. 62's	206								

A certain fixed number of days before that on which the old stock ends, the new stock can be opened up, it being understood that the old stock must all be put into rove before it can be closed. This arrangement will allow of the rooms being fairly credited or debited with the increased or diminished quantity of material in comparison with that of the previous stock-taking, and, besides, fairly shows the proportion of waste. When the old stock is all converted into rove, it should be sent to the spinning rooms, and stock there taken before any of the rove of new stock is sent up. The spinning-master can return an account of the number of full rove of each sort in the room, and the manager can add to this the number of rove of each sort that is in the spinning frame creels—divided by two, as half the full rove is a fair creel average—and thus have the correct rove stock. From having had the nett weight of rove on ten full bobbins of each sort calculated, by placing ten empty bobbins in one balance and ten full ones in the other, and, taking the weight of the difference, the manager can readily calculate the nett weight of each sort in stock; which when added to the sliver stock, leaves nothing remaining to take account of in the

Description of Frame.	Heads per Frame.	Rows per Head.	Deliveries per Head.	Slivers per Delivery.	Length of Reach.	Breadth of Gill.	Breadth of Conductor.	Length of Pin.	Pins per Inch.	Rows in Stock.	Wire Gauge.	Pitch of Screw.	Pitch of Boss.	Boss Roller Diameter.	Spindle Blade Diameter.	Bobbin Head Diameter.	Traverse of Bobbin.	Can Internal Diameter.	Pressure on Roller.	Draft on Frame.
Coarse Long Line System, for from 16's to 30's Lea Line, 50 to 90 yards Rove, Bell 700 yards.																				
					In.	In.	In.	In.				In.	In.	In.	In.	In.	In.	In.		
One Spread Board	1	6	1	6	36	4	3	1 3/4	9	2	16	11/16	6 1/2	3 3/4	..	..	..	13	800	35
First Drawing	2	6	1	18	30	3	2 1/2	1 3/8	10	2	17	5/8	5	3	..	..	..	12	600	16
Second Drawing	2	6	1	12	28	2 1/2	1 3/4	1 1/4	11	2	18	1/2	4 1/2	2 1/2	..	..	..	11	500	15
Third Drawing	3	8	2	8	26	2	1 1/4	1 1/8	13	2	19	7/16	3 1/2	2 1/4	..	..	..	10	400	14
Roving Frame	6	10	10	1	24	1 1/8	1/2	1	15	2	20	1/2	3	2 1/4	7/8	4	8	..	300	14
Medium Long Line System, for from 35's to 60's Lea Line, 90 to 130 yards Rove, Bell 800 yards.																				
Two Spread Boards	1	6	1	6	32	3	2	1 1/2	12	2	18	1/2	5	3	..	..	..	12	600	35
First Drawing	2	8	1	16	28	2 1/2	1 3/4	1 1/4	14	2	19	1/2	4 1/2	2 1/2	..	..	..	11	500	16
Second Drawing	2	8	1	16	26	2 1/4	1 1/2	1 1/8	16	2	20	7/16	3 3/4	2 1/4	..	..	..	10	400	15
Third Drawing	3	8	2	8	24	1 3/4	1	1	18	2	21	3/8	3	2	..	..	..	9	350	14
Roving Frame	6	10	10	1	22	1 1/8	5/16	7/8	20	2	22	3/8	2 1/2	2	3/4	3 1/4	8	..	250	14
Fine Long Line System, for from 65's to 100's Lea Lines, 130 to 200 yards Rove, Bell 1,000 yards.																				
Two Spread Boards	1	8	1	8	30	2 1/4	1 3/8	1 1/4	18	2	21	7/16	4	2 3/4	..	..	..	11	450	30
First Drawing	2	8	1	16	26	2 1/4	1 3/8	1 1/8	20	2	22	7/16	4	2 1/4	..	..	..	10	400	15
Second Drawing	3	8	1	16	24	2	1 1/4	1	24	2	24	3/8	3 1/2	2	.	..	..	9	350	14
Third Drawing	3	8	2	8	22	1 1/8	5/8	7/8	28	2	25	5/16	2 1/4	1 3/4	..	..	..	8	250	13
Roving Frame	7	10	10	1	20	1	3/16	3/4	32	2	26	5/16	2 1/2	1 3/4	5/8	3 1/4	6	..	200	13
Fine Cut Line System, for from 100's to 200's Lea Line, 200 to 400 yards Rove, Bell 1,500 yards.																				
Two Spread Boards	1	6	1	6	18	2	1 1/8	1 1/8	25	2	24	3/8	3 1/2	2	..	..	..	10	400	20
First Drawing	2	6	1	12	17	1 1/2	1	1	30	2	26	5/16	2 3/4	1 3/4	..	..	..	8	300	15
Second Drawing	3	6	1	12	16	1 1/4	3/4	7/8	35	2	27	5/16	2 1/4	1 5/8	..	..	..	7	250	14
Third Drawing	4	6	1	12	15	1	1/2	3/4	40	2	28	1/4	2	1 1/2	..	..	..	6	200	13
Fourth Drawing	3	8	2	8	14	7/8	3/8	5/8	45	2	29	1/4	1 7/8	1 3/8	..	..	..	6	175	12
Roving Frame	7	10	10	1	14	3/4	1/8	1/2	50	2	30	3/16	2 1/4	1 1/4	5/8	3	6	..	150	12
Very Fine Cut Line System, for from 200's to 400's Lea Line, 400 to 800 yards Rove, Bell 1,500 yards.																				
Two Spread Boards	1	8	2	4	17	1 1/2	7/8	1	36	2	26	5/16	3	1 3/4	..	..	..	10	300	15
First Drawing	3	8	1	8	16	1 1/4	3/4	7/8	36	2	26	1/4	2 1/4	1 5/8	..	..	..	8	250	14
Second Drawing	3	12	2	12	15	1 1/8	5/8	3/4	40	2	27	1/4	2	1 1/2	..	..	..	6	225	13
Third Drawing	3	8	2	8	14	1	1/2	5/8	46	2	28	1/4	1 7/8	1 3/8	..	..	..	6	200	12
Fourth Drawing	4	8	2	8	13	3/4	1/4	5/8	51	2	29	3/16	1 3/4	1 1/4	..	..	..	5	150	11
Roving Frame	7	12	12	1	13	1/2	1/12	7/16	60	2	30	3/16	2	1 1/8	9/16	2 3/4	4	..	100	12

NOTE.—All sliver cans to be as deep as the frames will admit between the delivery roller boss and the floor, say 38in. or 40in. The inside diameter of roving flyer to be not greater than what will clear the bobbin head, at the narrowest part of flyer.

preparing and spinning but the quantity of yarn spun up to the time at which the rove stock was taken in the spinning room, but no longer.

Cost of Preparing.

With properly regulated and adapted machinery, preparing can be done at about, for very coarse, 2d.; for medium, 4d.; and for very fine, 6d. per bundle of yarn of 60,000 yards, single rove. We say single rove, because it is now a common practice, where extreme levelness of yarn is aimed at, to prepare the rove double—that is, to prepare it so light that two strands of rove may be spun into the one thread of yarn on the spinning frame.

Double Rove.

However, to prevent the spinning draft being too long, the rove has to be brought forward so excessively light, as in our opinion, to outweigh any benefit gained by doubling on the spinning frame, from the increased tendency of the material to be impoverished by licking-up in the preparing. If the preparing machinery be properly adapted, single rove will give as good, if not better, results than double rove, and at about half the cost.

Preparer's Wages.

The average wage of preparing room hands has ranged as follows during the last quarter of a century :—

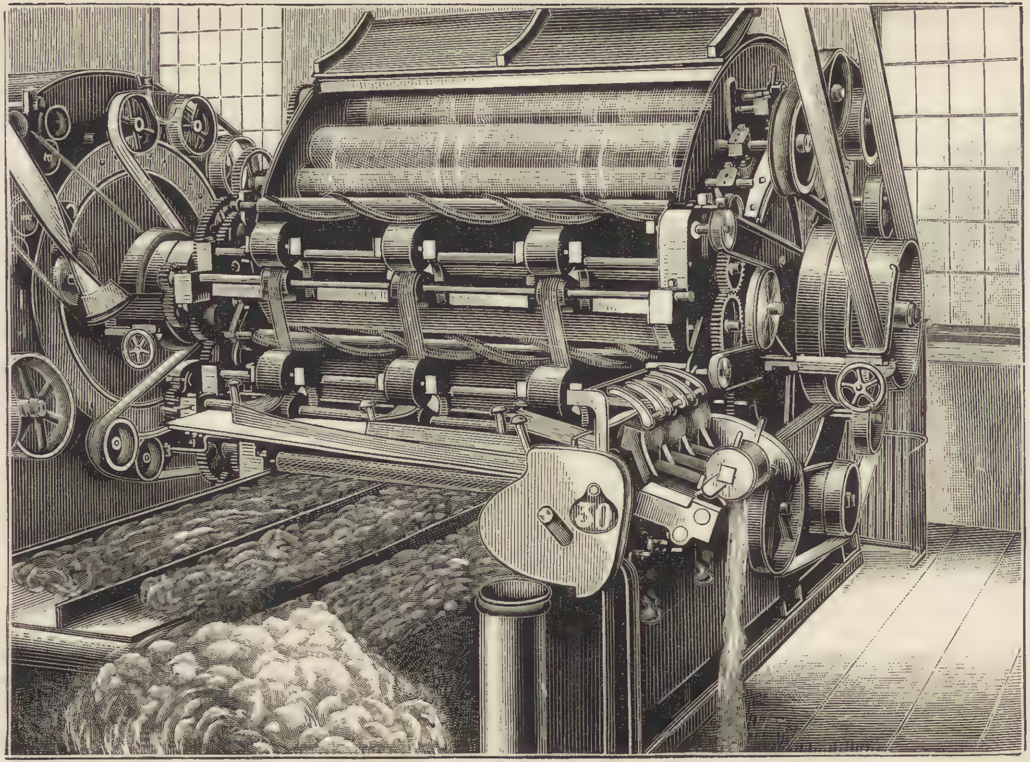
	1855.	1865.	1875.	1884.	
Spreaders	9d.	12d.	14d.	14d.	per day.
Drawers	8d. to 9d.	11d. to 12d.	13d. to 14d.	13d.	
Rovers	9d.	12d.	14½d.	14d.	
Doffers	5d.	8½d.	11d.	10d.	

Line Preparing Machinery.

We have given on previous page full particulars of five preparing systems, which between them are quite capable of preparing for the whole range of line for wet spinning—that is, from 16's to 350's lea line.

PART III.

TOW PREPARING DEPARTMENT.



CARDING ENGINE.

CHAPTER XI.

THE CARDING ENGINE.

Carding Department.

THE carding department is that in which the short fibres and impurities that come off flax during its scutching, machining, and dressing, and which are called tow, are put through a process differing materially from "flax preparing." The main difference is in the preparatory process, that of forming the tow into sliver. To effect this the carding engine is brought into requisition, and performs the same office to the tow that the spread board does to the flax.

The refuse that drops from the handles in flax scutching is shaken free from a large portion of the husk or shoves, and put into the market as scutching-tow, at some few shillings per hundredweight. The coarse tow spinner either puts this scutching tow through shaker and breaker cards, or gets it re-scutched over finer and lighter handles than those for flax, at the cost of about 4s. per cwt., made work, about 25 per cent. of which can be got out of ordinary scutching tow. This makes broken or re-scutched tow worth about 20s. per cwt.

Breaker Card.

This tow is then put through a coarse card—sometimes mixed with the coarser tows made during the flax machining and dressing, and which are called "milled tows"—and then carded over finisher cards, and prepared for spinning into tow yarns. The breaker card is composed of a large drum, or cylinder, of cast-iron, any size from three to five feet diameter, and four to eight feet across, or "face." This cylinder revolves at great speed upon its axles, which rest upon powerful cast-iron stands or gables. These gables are shaped to carry also the axles of numerous rollers of similar face, but of much smaller diameter ; and revolving in different directions, but parallel and facing close up, to the surface of the cylinder. Both cylinder and rollers are covered with clothing of steel pins of any required size. The

Card Feed Sheets.

tow is placed upon the "feeding sheets" in front of the card, these sheets slowly revolving in towards the bottom of the cylinder. Before it leaves the sheets it has to pass between two rollers parallel to one another and to the face of the cylinder. These rollers are about three inches in diameter each, and revolve in opposite directions, and inwards towards the cylinder. They revolve at a surface speed of about 16in. to 26in. per minute, and are called "feed rollers," because they are the medium through which the cylinder receives the tow.

Card Cylinder Staves.

The cylinder revolves downwards, striking and carrying away the tow from these feed rollers. It is covered with pins of about $\frac{7}{8}$in. in length, set at a slightly downward inclination or rake, through the wooden clothing, called lags or staves, which are screwed to the cylinder. These staves are usually from $\frac{3}{8}$in. to $\frac{5}{8}$in. in thickness, by about 3in. broad and 2ft. long. Thus the actual length of the pin over the clothing is from $\frac{3}{8}$in. to $\frac{1}{4}$in.

The points of these pins face close up to the pins in the feed-rollers ; and as the latter gradually deliver the tow forward, those of the cylinder strip it away, but not too quickly nor in lumps, as the pins of the bottom feed-roller—the roller on which most of the tow naturally lies, the top-roller

being merely a hooker-in—are hooked against those of the cylinder, so that the latter does not take much away at once, and the fibres of what it does get are pretty well broken by splitting between the pin points.

Card Stripper Roller.

To prevent the tow becoming bedded in the pins of the bottom feed roller, there is another roller of about 6in. or 8in. in diameter facing close up to the underside of the former, and also to the cylinder. This is the "feed stripper," and as it revolves at a high rate of speed in towards the cylinder, and has pins hooked in towards those of the latter, and also of the bottom feed roller, it strips the tow out of the pins of the feed roller, and is then itself stripped by those of the cylinder. The tow is now carried round by the cylinder until caught up by the next but one succeeding roller, towards the under side of the card. This roller is about the same diameter as the feed stripper, and revolves slowly in an opposite direction to the cylinder, and has its pins hooked against the pins of the cylinder; so that they lift away those fibres that are on the cylinder, and at the same time splitting them still more between the points. This roller is called the "first worker"; and is stripped by the roller that is between it and the feed-stripper, which is called the "first stripper." This latter revolves at a high rate of speed in the same direction as the worker, stripping the fibre off the worker and giving it back to the cylinder. As the pins of the strippers and cylinder work in towards one another, there is only a delivering of the fibres from the former to the latter, all the cutting being done between the pins of the cylinder and those of the workers; the pins of the latter being hooked against those of the former, and revolving slowly in an opposite direction. Thus the continuous action of retaining, stripping, and delivering, causes the cleaning, equalising, and splitting of the fibre to any required extent. This is continued right round the cylinder, over few or many pairs of workers and strippers, according to the fineness of the breaker card, until we see the "braird" upon the last worker, to be stripped off by the preceding stripper, and then carried past this worker by the cylinder, until it be intercepted by the next roller. This is one of large size, and working in the same direction and on the same principle as the worker, but without a stripper roller to clean it.

Card Worker Roller.

Carding.

Doffing.

The tow has to be taken off this roller by a quickly-oscillating knife, which beats down the tow from the pins of this "first doffer," as it is called. The tow is then separated into three divisions, and is drawn through calender rollers in the form of a coarse sliver. In a similar manner is the fibre stripped off one or two other doffer-rollers beneath this first doffer, and these united deliveries, after passing into a can, are taken to a machine and lapped on to large bobbins or reels set to receive this rough first carding. These reels, when full of the tow sliver, are taken and set in a rest before the feed rollers of the finisher card, in the place occupied by the feed sheets in the breaker card. The finisher card is on the same principle as the breaker card, only with finer and shorter pins, and more pairs of rollers of smaller diameter, to give the tow more work.

Finisher Card.

For the better and finer classes of tow one carding suffices, this being performed over a card called a "breaker and finisher," which combines the two above-mentioned machines, as the name implies. In this card the tow is passed in off-feed sheets, and is delivered in an even body, to be separated into as many slivers as there are front conductors. All the slivers then pass through the conductors of the bottom doffer, and on to what is called a sliver plate, which is a polished cast-iron plate of the full breadth of the card, and deep enough to permit of the various slivers into

Sliver-plate.

which the deliveries have been doubled, being carried round horns, then along the sliver plate, and into the back conductors of a small card-drawing head, called a rotary, attached.

Rotary Head. This head derives its name from the revolving or endless motion given to the fallers by their being driven, not, as is generally the case, by the spiral screw, but by a revolving shaft boxed in at both ends by circular brass plates. The plates are slotted radially with holes, to the number of fallers in the head. The ends of the fallers pass through these slots, and are confined in a groove of peculiar shape, facing close up to the revolving plate, on the outside. These stationary grooves are shaped to give the proper angle and throw to the fallers as they are propelled forwards, thus avoiding the expense of screw mechanism. Of course the approach of the faller to the nip of boss and feed rollers is not all that might be desired, or that could be accomplished with a spiral screw, but it suffices when working with limited length of draft—sometimes only one and a half and never more than four—and the coarseness of the material drafted. In fact, very short drafts, which are so beneficial in the preparatory stages of the preparation of tow and all short fibres, could not be accomplished with the use of the spiral screw, unless at the cost of great wear and tear of the machine from overdriving; or increased and unnecessary expense incurred by being compelled to drive the whole card slow enough to procure an ordinary speed for the faller.

As an improvement upon the rotary drawing, there has recently been brought out in the machine works of Lawson and Sons, Leeds, a card-drawing head, which may be styled of the dog-link motion. This arrangement is an adaptation of, and improvement on, the old chain link. The advantages claimed for it, are:—The nearer approach of the faller to the nip, and the greatly-increased durability of the machine, from most of its working parts, as the dogs, slides, guide-pins, etc., being of cast malleable iron.

The principle upon which this head works is, that the faller ends are passed through a link chain, and terminate in dogs or catches, which guide and keep the faller in position, by bearing on and against grooved slides. By this arrangement the radial or direct outward fling of the faller, as in the older style, can be confined to a more upright position, on its approach to the boss roller, thus shortening the nip. In the same manner the upward motion of the faller into the sliver, from below, can be made more direct.

With this dog-link the fallers cannot be got out of the head, unless in a sheet, they being linked together. This objection is met by the increased durability of the working parts, rendering the necessity for their removal less frequent; as, even if the gills require repair, the fallers need not come out, as the gill can be screwed off, the old style of screws, instead of rivets, being resorted to.

Another improvement connected with the new card-drawing head is that the sliver is delivered from the end, instead of the front of the doubling plate. This allows of the sliver can standing towards the front, instead of the side, of the card, thus bringing it more under the eye of the carder, or woman in attendance, and leaving more room besides.

The manner of driving these card-drawing heads is as follows:—There is a horizontal driving shaft working under the sliver plate of the card. This shaft receives motion from a train of gearing taken off the first stud follower—which in this instance acts as an intermediate—from the cylinder pinion of card. A clutch wheel, the last of this train, on the end of the driving shaft referred to, runs slack until a "feather clutch" working on the shaft is interlocked with it; when the power is transmitted through the shaft, by means of bevel gearing, to what may be called the "rotary driving shaft." To understand the gearing of a "rotary," so as to draft it, is

difficult, from the fact that it is the speed of the boss roller that is altered to change the draft. The speed of the feed roller cannot be changed unless in ratio with the delivery from the card, as the "take-up" must remain unchanged. But, as the feed must always be divided into the delivery, to give draft, therefore is the theoretical delivery applicable, without alteration, to the rotary. The speed calculation is—

Speeds of Rotary.

	195	speed of card cylinder
	30	speed, or cylinder pinion
First stud follower	150)5850	
	39	speed of first stud follower
	150	teeth in the first stud follower
Clutch wheel....................	35)5850	
	167	speed of bottom driving shaft
	30	bevel leader
Bevel follower	.25)5010	
	200·4	speed of rotary driving shaft
	24	first leader
Stud follower....................	28)4810	
	171·7	
	16	stud leader
Feed roller wheel	48·⁰)2747·2	
	57·23	revolutions of feed roller, dia. 1¾.

	201	speed of rotary driving shaft
	24	first leader
Boss roller wheel...............	48)4896	
	57·23 102	revolutions of boss roller, dia. 2in.
	1·75 2	
	101·15)204·⁰⁰	
	2·03	draft.

$$\text{Or, } \frac{24 \times 28 \times 48 \times 2}{48 \times 24 \times 16 \times 1\frac{3}{4}} = 2\cdot00 \text{ draft.}$$

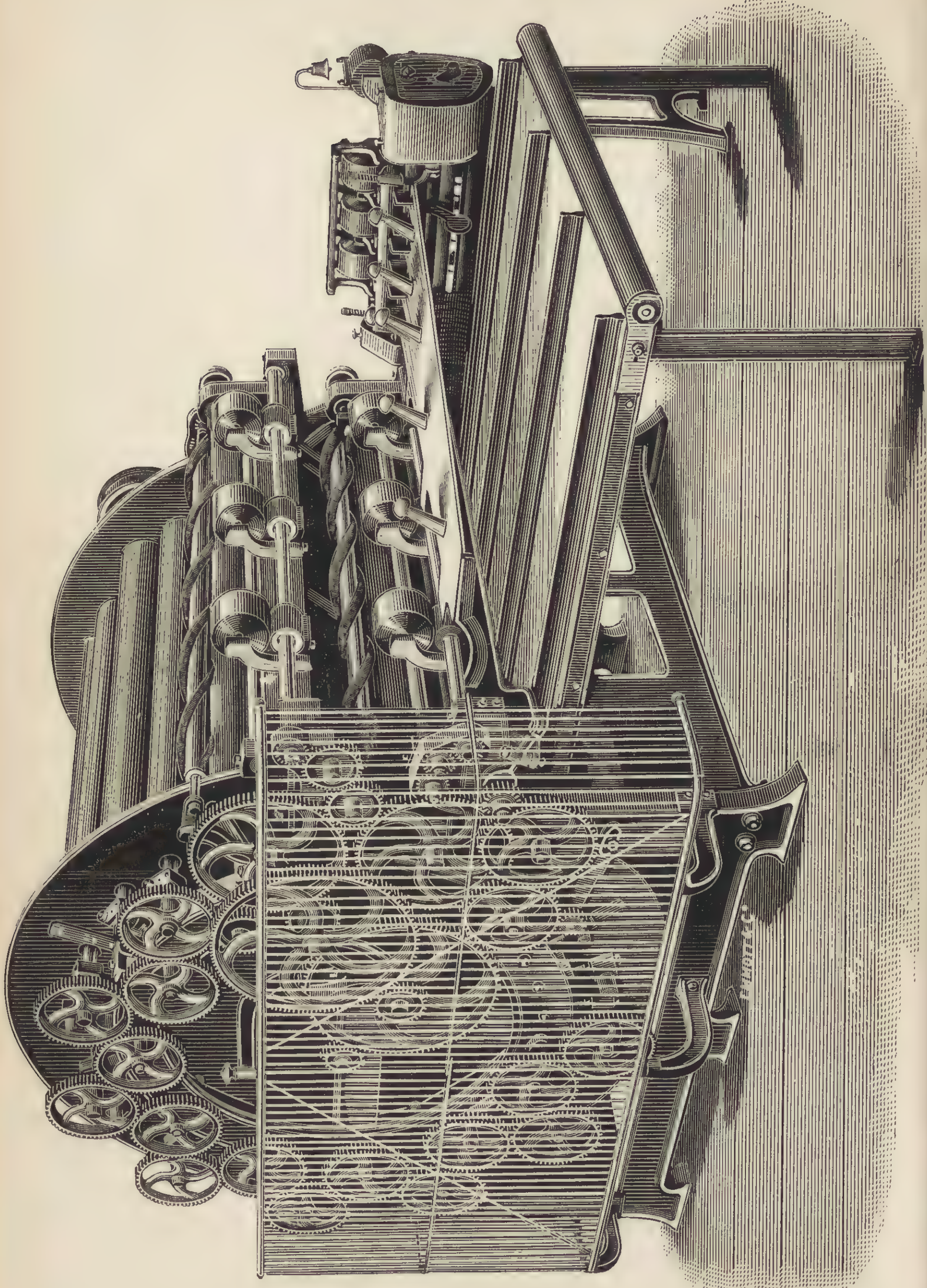
Names.

$$\frac{\text{Change pinion} \times \text{Stud follower} \times \text{Feed roller wheel} \times \text{Boss roller diameter.}}{\text{Boss wheel} \times \text{Inside leader on driv. shaft} \times \text{Stud leader} \times \text{Feed roller diameter.}}$$

The drawing of the card sliver through a very coarse open gill, and on such short draft over this rotary, prepares it for the more elaborate treatment on the first drawing frame. Besides, the sliver off the rotary is not nearly so liable to be tossed or "shired" as it would be if in the form of undrawn and uncompressed card sliver. The sliver-can will also hold more of this formed sliver; thus lessening the wear and tear upon cans, and being productive of less piecings at the back of the drawing frame.

Gills in Rotary.

There are one, two, or three rows of gills in the rotary head, according to taste. One gill is not sufficient, as it would be overloaded with sliver, and the single pressing roller would require two hangers and levers to it, one from each end of the arbour. If both levers be not screwed up alike, and with similar pressure on each, the



pressing roller will lean to one side, thus producing unevenly-drawn sliver. Instances have occurred in which maliciously-disposed persons have purposely taken advantage of this, to produce dirty, lumpy yarn, in order to injure the reputation of some obnoxious manager or overlooker.

The three rows of gills, and therefore the three boss pressing rollers, have the advantage of a light load on each gill, and no overriding of the card slivers passing in; but they have the disadvantage of precarious balance above referred to. The two rows of gills permit of the pressing roller being weighted from between the bosses, but have the disadvantage of being difficult to load evenly, as there are generally three deliveries across the face of the card, making an odd number of slivers to one of the two gills.

It is considered by many persons that instead of the rotary being an improvement to a card, it does harm, by "shiring" the sliver, on account of the great speed at which the parts have to be driven. For this reason, in many establishments the rotary is not applied at all, but the card sliver is passed direct to a drawing or "Bell frame," as it is called, to prepare the sliver for making up into "sets."

Filleting.

The plan of clothing the cylinder of cards with wooden "staves," already referred to, is of comparatively recent date. A more old-fashioned method is the use of "filleting" for the cylinder, as well as for the rollers of the card. This filleting is of leather of any width—say one, two, or three inches—generally two inches, filled in with wire staples set to any angle and number of pins per square inch. But as the whole stress of work is upon the cylinder pins, the filleting could not always be made strong enough to withstand the strain; especially when it became hard and dry, and had loosened on the cylinder. There will always, also, be a certain amount of hard substances that will pass in with the tow, and tear up the pins, notwithstanding the most careful feeling for them on the part of the "carder," as she spreads the tow. As the pins of filleting cannot be tempered, they soon become blunted and unfit for work; but they cannot be renewed unless by the winding off of the damaged portion, cutting it out, and then inserting a fresh piece. All this involves immense labour and loss of time. Then the filleting sometimes breaks, and the ends thus set at liberty are lapped round the rollers, until held in check by the retaining screws screwed into the filletting at intervals. This lapped clothing often entirely smashes some of the rollers, and even knocks a hole in the cylinder itself, besides rendering the rest of the clothing useless. In fact it has often endangered life, and wrecked property to the extent of hundreds of pounds. One plan for the prevention of such occurrences is the covering of the leather with brass or zinc sheeting, the pins passing through all; but this was expensive, and besides, did not card so freely on account of the tow catching on the "burr" formed by the drill round the root of the pin. Subsequently the wood clothing was brought into use. This is screwed firmly, in distinct parts to the cylinder; and long trial has proved this arrangement so efficacious in every way, that it is now common to see not only cylinders, but feeds, strippers, and doffers all covered with the "lags." The difficulty in the way of clothing the "workers" in a similar manner is that as yet the requisite "knee bend" cannot be got into the tempered steel pins with which the "lags" are filled.

The proper curve and requisite lap—according to the diameter of the cylinder of the roller to be clothed—is now given by machinery, and these "lags" of well-seasoned beech can be made to lie as close and level as filleting itself. Wood clothing can also be made of any length of pin over clothing, and any number of pins per square inch, to suit circumstances.

Keenness of Clothing.

The manner in which a card will "clean" itself, and the quality of the "waste" it will drop, depend much upon the "keenness" of the clothing—that is, the proper "rake" or

angle of the pins to their "stock." A fair average is—feed rollers, 60 to 65 degrees; workers, 45 degrees; strippers, 55 degrees; doffers, 35 degrees; cylinder, 75 degrees. The pin points can be either needle, sectoral, or diamond pointed, according to taste and requirement; and the pins of at least the bottom workers should be "knee bend," to prevent fibre dropping. These remarks apply to leather filleting also; and, as a sort of guide to the proportionate density of filleting in relation to the wire gauge, we give the following table:—

CARD FILLETING.

Grades of Filleting.														
Wire gauge =10........	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Pins per in. =2×2......	2×3	2×4	2×5	3×5	3×6	3×7	3×8	4×8	4×10	5×10	5×12	5×14	6×14	6×17
Pins per sq. inch=4....	6	8	10	15	18	21	24	32	40	50	60	70	84	102

Of course it is advisable to introduce more or less "pins per square inch," according to circumstances, the above table merely illustrating fairly-proportioned filleting, neither too open nor too close.

Covering Rollers. To cover the rollers with this filleting, all that is necessary is, to lap or wind the filleting round the rollers at a certain angle; it being well stretched as it is being put on, by being turned once or twice round a retarding round-bar of wood. The filleting being started at a certain angle gives the row going on an inclination to overlap the preceding one, which, however, only forcibly presses one row against the other, making the whole one firm close sheet. The proper angle is found by the diameter of the roller to be covered being measured off from the extremity of the filleting; and from the point thus procured, the side of the filleting is to be pared off in a straight line, to nothing at the extremity. This newly pared edge being faced up with the edge of the roller will set the fillet on the proper angle. To thus cut or pare filleting, it is necessary first to remove, with the aid of a prize awl, all the pins impinging on the straight line.

To find the length of filleting necessary to cover a roller, multiply the diameter of that roller, with the thickness of one ply of the leather added, by $3\frac{1}{7}$, to find the circumference. This multiplied by the rows across will give the length in inches. Or if a foot or two over length be required for holding purposes—although a piece of strong cord tied to the end would suffice—the diameter of the roller, with the thickness of the two ply added, must be taken as mean diameter. A contraction of this rule, as applied to 2in. broad filleting going on a 6ft. "face" roller, is:—Multiply the roller circumference in inches by three, which gives the requisite length in feet.

Card Calculations. The relative speeds of different portions of the card may be as follow—

Speed of cylinder 210 revolutions per minute
58 cylinder or speed pinion
First stud follower 200)12180
60·90
40 first stud leader
Second stud follower 200)2436·00
12·18
60 second stud leader
Doffer wheel 122)730·80
5·99 revolutions of doffer roller per min.

Follower on boss roller end 26)730·80 power of second stud leader

28·11 revolutions of first del. roller

Follower on boss roller end 25)730·80 power of second stud leader

29·23 revolutions of second del. roller

Follower on boss roller end 24)730·80 power of second stud leader.

30·45 revolutions of third del. roller

5·99 revolutions of doffer roller
25 doffer or "change" pinion

Feed roller follower 63)149·75

2·37 revolutions of feed rollers per min.
3·25in. dia.

7·70

28·11
29·23
30·45

3)87·79

29·26 average of delivery rollers
4·25 diameter, inches

7·70)124·35

16·1 draft of card

---

210 cylinder revolutions per minute
15in. knife pulley diameter

Dia. eccentric pulley 5)3150

630 revolutions, or "doffs" of knife per min.

---

210 revolutions per cylinder
16in. diameter of stripper drum

Stripper pulley dia. 13)3360

258·50 revolutions of strippers per minute

Worker stud follower 80)730·80 power of second stud leader

9·13 revolutions of first worker follower
24 stud leader (to workers)

Worker wheels 104)219·12

2·10 revolutions of workers per minute

In the theoretical drafting of a card there is necessity for only two pairs of wheels, and the diameter of feed and delivery rollers, thus:

$$\frac{122 \times 63 \times 4{\cdot}25}{25 \times 25 \times 3{\cdot}25} = 16{\cdot}1 \text{ draft.}$$

Names.

$$\frac{\text{Doffer wheel} \times \text{feed wheel} \times \text{delivery roller diameter}}{\text{Doffer pinion} \times \text{delivery roller wheel} \times \text{feed roller diameter}}$$

CHAPTER XII.

CARDING.

It requires considerable power to keep a card full of tow up to its proper speed. Economy in this particular should be practised by having the card standing perfectly level, by careful oiling, and by having the drum and pulleys as large as circumstances will permit, thereby giving the driving belt greater power, on account of its having more purchase.

Card Driving.

If full speed be not kept up on the card, through the belt slipping, very dirty sliver will be produced, through the loss of the necessary centrifugal force. To prevent this, it will be necessary to keep tightening the belt, and so damaging it ; and wearing the cylinder sooner off its true centres by the one-sided strain imposed on it. If the cylinder and rollers are not level and true, it is impossible to card properly. To give the belt sufficient biting power, powdered resin and oil is sometimes applied. Sparks of this paste in time fly off, and lodge among the slivers and gills of the machinery, causing laps, chokes, and breakages. This expedient is thus even worse than that of contracting the belts ; and there is, in fact, no successful remedy, unless drums and pulleys of large size and fair breadth of face are used.

Spreading the Tow.

The tow should be carefully shaken and picked by the carder before she puts it into the scales, to weigh the exact lap that she has to spread over a given distance on her sheet. The lap of tow, when it is spread level over the prescribed area, causes the quantity passing into the card to be equalised ; and just as the card receives the tow so it gives out the sliver. A lap may be from 2oz. to 8oz. weight of tow, and the area over which it is spread about 28in. long by 23in. broad. As there are three feeding sheets to the front of the card, there are three laps passing in simultaneously. The gearing of the feed-rollers of the card should be so arranged, that any hard or foreign substance which has escaped detection by the carder, on being delivered into them will choke them, and thus stop the feed. This will certainly save thousands of pins, and perhaps the crushing in of a roller, or of the cylinder itself. The arrangements to secure this end are numerous : about the most simple and effective being to have the intermediate wheel, between the change and feed wheels, working on a rocking stud. This stud being set in a balance lever, to the other end of which a suitable weight is attached, if undue pressure is exerted on the intermediate wheel, in the endeavours of the feed-rollers to take in the hard substance, this pressure more than counterbalances the pressure of the weight on the lever, and so depresses the latter and draws the intermediate wheel out of gear.

Prevention of Breakages.

Cards should not be refilled with tow after cleaning, or, as it is called, "blowing through" on Saturdays, as the tow has a tendency to absorb damp, and so to tarnish, or perhaps rust, the pins. The observance of this rule is important for another reason. If the overlooker, boys, or mechanics, have chanced to be performing some duty about the card, after it has been left in readiness for a fresh start, with the tow in it, they may carelessly forget to lift some article laid down for the moment upon the feed-sheets. This

article (picker, etc.) will be partly covered by the tow, and may escape the carder's notice when she comes to start her card ; and in this case, if there be no device, such as that above-mentioned, to prevent its entrance into the cylinder, the card may be rendered nearly worthless. Besides this, the leaving of the cards empty permits the hackle-setters to do their work more satisfactorily, as they are not left to depend too implicitly on the carding-master's opinion as to which cards require overhauling most. Some overlookers really know or care very little about the condition of their cards, especially the bottom rollers, and it is to the hackle-setter's interest to examine for suitable work.

Waste Drawing.

The person whose business it is to draw the cards—that is, to take out the card waste from the pits—should be severely dealt with if too much waste be allowed to accumulate ; as when it rises too high the strippers lick it back, and thus is caused much of that especially dirty sliver or bad yarn, that gives those in authority reason to think that the tow sorter has been careless in making his mixings, or that the quality of the tow must be sadly deteriorating.

Card on Fire.

If the card happens to take fire, from a match, etc., being in the tow, or from heated journals, careless setting, turned pin points, or some such cause ; when the pit is too full of waste, the fire will last so long, and such heat be generated in the card as may render it nearly worthless by taking the temper out of the pins, and charring the filleting. The chance of the fire spreading is also very much increased. To guard against this latter danger there should be one or two buckets, filled with water, kept at each card ; to be used only for drenching the waste in the pit, and for wetting the floor about the card, to smother the sparks in case of fire. No water should be thrown over the card, nor should it be stopped, but let work away at full speed, as this prevents the fire settling on any particular spot, and keeps up a draught that saves the pins and clothing.

In some establishments it is considered worth while to have a range of water piping under pressure, behind each card, with short, handy tube or hose attached, so that there may be always an abundant supply of water ready to be directed to any point. The first and most important thing to be done on a card taking fire is, for the carder to throw the feed-rollers out of gear, by pulling the intermediate wheel off its stud. She must then pull back all the tow that has not entered the feed-rollers, off the sheets, so that there may be nothing to burn but the small quantity of tow and waste in the card. The other cards in proximity should be at once stopped, so that if any burning matter is flying about, and happens to light on them, it can be easily put out by persons stationed at the different cards, prepared for the emergency by having hand-brushes saturated with water, ready to quench the igniting portion, with the least possible wetting of the card. Quite as likely a way for the fire to spread rapidly is by the dusty floor, which makes a train of communication between the cards. It is to ensure safety in this direction, that the floor must be flooded, and there should also be wet bales at hand. In some places, where regard is paid to the health of the workers, the cards are covered in, and connected with each other by means of pipes branching out of the top cover of each, into one large central funnel, which is carried into the open air, and has a Schiele or some such fan attached, to exhaust the air, and so draw away the "pouse" from the cards. The arrangement is very efficacious, but very injudicious ; as, if a card takes fire, it is more than probable that by means of this connection all the others will take fire also. This would endanger the whole establishment, as much dust gathers in the corners and recesses of the pipes.

Covered and Uncovered Cards.

Not to cover in the card at all, would be very injurious to the health of the girls, and be no safeguard against fire spreading, but rather a help to its doing so, as it is then hardly

possible to prevent at least two or three cards taking fire before they can be stopped. A single spark from the burning card will set on fire, literally in the twinkling of an eye, that which is uncovered and working, as the cylinder takes the fire round and round the card in a moment. The proper method to adopt is to have the cards nicely covered in, but in no way connected, and at least four feet apart; for provision against the fire spreading. Powerful screw fans can be inserted in the air pane of one or two windows at each end of the room, to draw off all dust; or there can be a large funnel, with bell mouths, here and there, opening into it, ranged up the centre of the room, but not too near the cards; and a Schiele fan at each end. These fans are troublesome, requiring most perfect lubrication to prevent their catching fire. The writer remembers that in one case, when the oil froze in the cups, during a severe frost, the fan soon caught fire, igniting the dust in the funnel, and sending back clouds of smoke and sparks into the carding-room; when it ceased revolving, from expansion. The heat was so great as to melt the solder off the joints of the tin funnel. On another occasion, great difficulty was experienced in keeping the fan cool enough to work, and when the machinery was stopped during the meal hour, the heat in the fan increased to such a degree from the cessation of the draught, as to fire within half-an-hour; fortunately, the watchman perceived the blaze in time, and severed the connection between the burning part and the carding-room. The weak point of this fan is that it may prove most dangerous, though looked upon as harmless, when it is at rest.

Isolation of Cards.

Operatives' Prejudices.

Some proprietors arrange to have their cards in a room by themselves, and require their carders to wear respirators; which they have less objection to do when by themselves, and unobserved by others. The repugnance that the operatives, in the dusty and consumption engendering departments of Flax Mills, have to the wearing of these life-preservers is remarkable. They tacitly agree not to show their frailty—this only making its assertion more inevitable—by subjecting themselves to any precautionary measure whatever. Consequently it is appalling to see the ravages that a few years among this "pousy" and vitiated atmosphere, work upon once strong, healthy-looking young men, women, and children.

Ventilation.

The impure air of many of the rooms in a flax and tow spinning manufactory not only tend to shorten the lives of the workers, but it is one and not the least powerful of the causes of that degeneracy in our manufacturing population which has latterly attracted so much attention. A great deal may yet be done to remedy so great an evil; and now that men have their minds directed to it, it is to be hoped that we are on the eve of great improvements.

As an illustration of the efforts that are being made in this direction, we give the following extract from the pages of the *Textile Manufacturer*: "Some time ago we described an arrangement of ventilation by which cool or warm air was introduced into mills which was on its way damped by being brought into contact with a spray of water. We see from our Continental contemporaries that a German spinner and weaver of some note has introduced into his mill a similar arrangement, which, however, differs a little from the above, and which, moreover, appears to be simpler. The fresh air is driven into the rooms of the mill from the outside by means of a fan, and enters the room near the ceiling, in order to avoid any draught. On its way it passes through the cellars of the establishment, where it is damped, and either warmed or cooled. The cellar contains stages made of wooden laths, placed about a couple of inches over each other. Over the top of these laths a pipe runs, through which, in winter, the condensing water from the engine passes, and in summer cool water from a well. This pipe is finely perforated, so that the water falls in a fine spray over the

laths, which, being of wood, retain much of it, and give it off to the air passing through the cellar. By means of valves the amount of water to be passed through the cellar and the volume of air to be passed into each room can be regulated. The vitiated air passes out of the rooms through ventilators, which are to a certain extent self-regulating. The ventilation is arranged in such a manner that the whole volume of air is renewed every 35 minutes, which amounts to about 85 cubic yards per individual employed in the mill. It is asserted that by this arrangement there is not the least draught; and that the hands are healthier is shown by their improved appearance. If we wished to add a moral, we should say that if this is of advantage in a mill situated in the open country, how much more requisite is it in those mills which are in towns, and surrounded by other buildings?"

Oiling of Card.

On account of the high rate of speed of the carding engine, and its consequent inflammability, nothing but the best oil should be used for lubricating purposes—say pure lard, or even sperm. The cylinder axles should be oiled after each start, or three times a day, which is sufficient when there is a cup over each bearing kept full of pure tallow and oil mixed, and where the journals have not been cut up and destroyed by previous heatings. The doffer, delivering roller, knife, and stripper journals should also be oiled after each start; and the rotary, the loose pulley, and the workers, feeds, and sheet rollers once a day. As the carders will not have their cards brushed and ready for a start for some fifteen minutes after the works are again started, the oiler will have time beforehand to go round the drawing and roving frames, in the same manner as described in the chapter on "Line Preparing."

Velocities of Rollers.

The speed at which the different rollers of the card should be driven depends much upon circumstances, as the openness and rake of their clothing, their diameter, the quality of the tow, the quantity to be passed through the card, and, lastly, the extent to which it is intended that the fibre is to be carded. Commencing with the cylinder, it is found that for it a velocity of about 3,000ft. per minute is best for most long line tows—that is, tows of fair average length of staple—and about 2,500ft. for tows of fine, close, short, and dead nature, as most cut line tows. Above all, it is necessary to give such velocity as will prevent the fibre from bedding in the pins. This remark applies to the strippers as well as the cylinders. The stripper rollers are driven at any number of revolutions from 150 to 500 per minute; a fair average velocity being 500ft. per minute. If the tow be dirty, and the percentage of waste is not of so much moment as the production of the cleanest possible sliver, fast strippers are the desideratum. In the case of the workers the reverse of this will tend to produce a like result—that is, slow workers yield clean sliver at the expense of waste. For an average size of worker, about $1\frac{1}{2}$ revolution per minute may be considered as slow, 8 revolutions as fast. Less cleaning, and consequently less waste, is effected by running the tow as quickly as possible through the card, by putting on a large "speed" or cylinder pinion, and so driving up both feeds, doffers, and workers.

How to Card Tow.

But it need not be thought that the science of carding can be reduced to such simple rules as the foregoing. Thus, it has been stated that slow workers clean the fibre, and consequently make waste, which is perfectly true; but it can with equal truth be said that fast workers also make waste. To show that this is so in both cases, it is to be remarked that slow workers, by receiving the tow from the cylinder slowly, leave more time for the breaking up or splitting of the fibre between the points, and also for the accumulation of a greater quantity of fibre upon the pins. In this case it is the splitting of the fibre that separates the dirt and impurities from it,

and thoroughly equalises the length of the staple. With fast workers, the points are in contact for a shorter period, consequently the fibre is so much the less broken up, and, besides, there is so much less of it taken up by the pins. There is, consequently, less fibre to be taken off by the stripper, which leaves more freedom for the shorter particles and impurities, and those longer fibres that are weighted with a sticking shove, to be thrown off by the centrifugal force of the stripper. Therefore, where the dirt in tow is a sticking shove, the workers, to clean it, must be driven slowly ; whereas, if the dirt be a loose shove, quite as good a result will be obtained with a fast worker. Following up these remarks, we may here state the likeliest ways to produce the best results from different classes of tow. For tows of soft, wefty, but dirty nature, as the poorer class of Irish machine tow, etc.: fast workers, fast strippers, and medium cylinder pinion. For tows of hard but dirty nature, as some Irish, Pernau, Friesland, and hand-scutched tows: slow workers, medium strippers, and large cylinder pinion. For tows of soft but clean nature, as Bruges, Dutch, Courtrai, and Irish sorting tows : fast workers, slow strippers, and medium cylinder pinion. For tows of hard and clean nature, as some Irish, Pernau, Dutch, and Friesland : slow workers, slow strippers, and large cylinder pinion.

Nappy Tows.

Nappy tows are very difficult to card to satisfaction—in fact, it is not an uncommon belief that naps cannot be carded out of tow, but that they are far more likely to be put into it, in the carding. Fast workers, fast strippers, and medium cylinder pinion, with close setting all round the card, is the best method of treating nappy tows. On the supposition that the nap generally remains on the pin points, whilst the fibre sinks into the pin, many persons have tried with very fair success, to cut away these naps by the application of a knife. To a good, strong angle iron is riveted a blade of steel, having a very straight and keen edge. This blade is brought close against the outside surface of one of the strippers (not above the centre of the cylinder), so that the sharp edge cuts away the nap, which slides off the knife into the pit. These knives require to be kept keenly set to the surface of the roller, and very close, and to be firmly secured to the circle of the card. One or more can be applied, according to taste. If they become too much buckled, and too blunt to be of much use in cutting the nap, they can be used as shoots to cause the shove to drop clear of the preceding pair of rollers, as the dirt is being thrown off above the centre of the card.

Setting the Rollers.

Remark was made above as to the "setting" of the rollers. This is a point of quite as much importance in carding as is speed. The setting means the distance between the extreme points of the pins of the rollers and those of the cylinder. These distances are gauged by the easy insertion, between the pin points, of sheets or gauges of iron, brass, or tin, of any size of the wire gauge. The same may be said of card setting as was said of card speeds—much depends upon circumstances and predilections. The general, and not unreasonable method of setting, is to set those rollers that are of the coarsest clothing at greatest distance from each other and the cylinder, and gradually to set closer as the rollers become finer, further round the card. The reason of this is that the tow is rough and unbroken as it enters the card, and consequently requires room and time to be graduated to the requisite degree of fineness.

Where this system is adopted, a very fair rule is to set the strippers to their worker and to the cylinder to a gauge of the same thickness as the wire of the stripper clothing ; the workers to be set to the cylinder a size more apart than their clothing gauge. Another method is to set the strippers to one gauge from their workers and cylinder all round the card and the workers to another gauge from the cylinder all round—say for

coarse cards, all the strippers to be 16 wire gauge from the workers and cylinders, and all the workers to be 14 wire gauge from the cylinder. For fine cards, all the strippers to be 20 or 21 wire gauge from the workers and cylinder; and all the workers to be 18 wire gauge from the cylinder; intermediate cards to be set to intermediate gauges. It is not uncommon to find persons who go to the opposite extreme, and set the rollers closer at the bottom of the card than the top; the argument in favour of this being that all the carding should be done in the bottom of the card, where the dirt can drop down, and so leave nothing to be done but a mere conducting of the fibre over the upper and top rollers, as there the dirt cannot fall away. If this argument is sound, of which there are serious doubts, one thing is certain, that the system is most injurious to the clothing of the card.

The writer, after full experience in each of these methods of card setting, would certainly give his opinion in favour of the intermediate course—that is, similar gauging for the strippers, and similar for the workers, all round. In this arrangement there is less chance of the upper rollers dropping in too close on the cylinder, from the wearing of the brasses, so as to completely smash up the fibre; and the maximum cutting will be given under the card, consistent with the minimum wear and tear of clothing. Great damage is done to the fibre by setting the feed-rollers too close to the cylinder, especially the bottom one. The latter should be somewhere about $\frac{3}{16}$ths of an inch from the cylinder, and the former $\frac{1}{8}$th, more or less.

Feeding in the Tow.

Many plans have been adopted for the prevention of the needless damage, and consequent waste, arising from the undue smashing of the fibre between the cylinder and the feed-rollers. First among these is the "shell feed" arrangement, in which there is only one feed-roller, of rather large size, and long pin, the rake of these pins being in the same direction as the run of the cylinder, so that there is no damage to the fibre between the points. The tow passes from the sheet to a plate or "shell," facing close up to the circumference of the feed-roller, thus pressing the tow into the pins, which are nearly vertical, and long enough to draw and receive it. The shell passes round the bottom of the roller and well up into the nip, or between it and the cylinder; and it is over this that the cylinder takes away the fibre evenly, and with more or less breakage, according to the shape of the shell at this critical angle or point. This arrangement works fairly well, but does not give such astounding results as were at first anticipated for it, as the tow is found to bolt more or less. Another arrangement is to increase the size of the feed-rollers, and to insert a smaller roller in the space between them and the cylinder, the fibre to be heckled in by the cylinder over this intervening roller. This arrangement can never become popular, as in it the tow is liable to choke up, and to lap round the intermediate roller, which may then be drawn in by the cylinder. The smaller roller cannot be made rigid enough to prevent this. The writer thought he was about to produce great results from the simple expedient of throwing out the ordinary feed-rollers some 15in. from the cylinder, and inserting in the space thus acquired an ordinary doffer-roller covered with either filleting or lags of about 16's wire gauge, 18 pins per inch, by $\frac{5}{16}$in. over clothing, nearly perpendicular. The clothing of the upper feed-roller required to be reversed, as this intermediate stripper revolved upwards, stripping both feed-rollers, and giving over the fibre to the cylinder. The supposed advantage was the taking in of the fibre from the feed-rollers, as if through heckles, instead of against pin points or any obstruction. The tow did not bolt on account of the interlocking of the feed-roller pins (brass porcupine), and the smaller space in which it could accumulate before being carried off. But the large stripper threw off so

much waste below it that the saving was *nil.* However, the same tow produced more "flaxy" looking sliver, and when it came to be roved had to be slackened out in the twist some 7 per cent.; conclusively proving the increased soundness of the material. The writer had this arrangement running on a card for seven years without any trouble whatever. It might be worth the expense of putting on new cards, if it were well fenced in order to prevent the fibre falling; but it is not worth the cost of application to existing machinery. The fact of a stripper being placed between the feed-rollers and the cylinder is not novel; but to have one roller stripping two others, and that perfectly, certainly is novel. The fencing-in above referred to is commonly practised where the saving of card waste is a desideratum. It may be effected either by wire netting or iron grating, encircling the different rollers and passing well up into the nip of each, or by a semi-circular and slowly travelling sieve extending around the whole bottom of the card, without passing up into the nip at all. The former is the more effective, and the latter the cheaper method. These gratings can be made to save more or less waste, according to the size of their mesh and the distance at which they are gauged from the face of the rollers. Many persons are prejudiced against such devices for card waste saving, as they contend that what is retained at the card will be more than counterbalanced in the spinning if increased waste and inferior turn-off and quality of article be included in the calculation. Persons holding this view—the writer amongst the number—consider it best not to attempt or hope to exclude all fibre from the card pit; but to have all card waste put through a revolving sieve, and to have the fibre thus obtained mixed with the laps, waste, pickings, and other fibrous etceteras of the concern, and put through a properly adapted card. This will produce a tow sliver quite capable of spinning to coarse tow numbers or of being mixed with that of medium weft tow numbers.

Card Grating.

Treatment of Card Waste.

Of Rollers, Size and Number.

Long stapled and strong tows require to be carded over rollers of large diameter, so that they may not lap round them and thus be debarred from getting a fair share of the carding process. Rollers of small diameter can be used even advantageously for tows of short staple, irrespective of the fact that the smaller the rollers, the greater the number the card can suitably contain.

Spacing of Card.

There is a certain proportion between the size and number of pairs of rollers to compose a well-adapted carding engine, thus: If the size of the rollers be too large in proportion to their number, the spacing between each pair will be so cramped that each worker will be "robbed" by the succeeding stripper; that is, the longer, and therefore better fibres will be carried away by the next stripper, before they have come within the influence of their own stripper; to the damage of the good fibre and the consequent increase of waste and impoverishment of the material. Or, if the distance between each pair be too great, the cylinder will throw off fibre unnecessarily to waste, and the beneficial action of another pair of rollers will be wanting in addition.

A properly spaced card is one in which the distance between each set of rollers approximates to half the sum of the diameters of the pair adjacent.

If the spacing be more open than this, much valuable fibre may be prevented from falling, by the introduction of plain tin rollers between the bottom pairs of rollers.

CHAPTER XIII.

CARDING ROOM TECHNICALITIES.

There is a nicety in regulating the quantity of tow to be passed through a carding engine so as to produce the best results, with the existing speeds and a setting of the rollers; or, rather, it may be said, that the speeds and setting of the rollers should, to a great extent, be regulated by the average quantity that it is intended to pass over them.

Weight of Lap.

This quantity is sometimes regulated by assigning a greater or smaller weight of tow to the "lap," according as a heavier or lighter rove be required off the tow system. The alteration in weight is effected by the changing of the weights—ounces and tenths—in the carder's scale; for instance, if, with certain drafts and doublings, a five ounce lap produces rove 50 yards per ounce, what weight of lap will produce rove 60 yards? Less, therefore as 60 : 50 : : 5 : 4·17 ounces, to produce lighter rove over that system. But the untrustworthiness of this now nearly obsolete method is apparent, from the fact that there will be a great variation in the quantity of card sliver out of different classes of material, so much greater or less percentage of waste and loss being in one kind than another. This difficulty could only be overcome by the carding room overlooker correctly guessing the probable percentage of waste, and proportionately regulating his weight of lap; and herein lay the secret how that some carding masters of old acquired the reputation of always keeping their tow yarns "right;" thus rendering themselves objects of emulation, if not of envy, to their less astute brethren. With this system much of necessity depends upon the honesty and care with which the carder weighs her laps; in fact, there is too much of guess work and chance about it; the only thing in its favour being the exemption from the necessity for sets.

Card Bell.

As a sort of improvement, the card sliver was sometimes measured off the card or rotary head by a bell, and the cans made into sets. But here again there was no element of certainty, as what with laps and stoppages of the card, the length of sliver delivered often fell far short of the length indicated.

Tow Sets.

The proper method, and that now usually practised, is to spread the quantity of tow most suitable for the card, without any weighing, but depending upon the carder to be guided by her sense of touch in spreading it as level as possible. This she can do, as the time otherwise occupied in weighing can be devoted to the exercise of greater care. This admits of the cans being doffed as required, and pieced up at the back of the bell-frame, to be measured into set cans at the front. These cans are then made up into sets, as described in the Line Preparing, and put up at the back of the set-frame.

If, from slight variation in either the quality of the tow or the carding of the sliver, the cans at the front of the bell-frame are much above or below their average weight, it will be necessary to pull down or put up a sliver at the back. However, this must never be done, unless at the ringing of the bell, and, with level tow sorting and carding, and a fair stock of set cans, need not be practised at all.

Uneven Cans.

Where this regulating of the weight of the set cans at the back of the bell-frame is com-

monly practised, it is certain evidence of either careless sorting of the material in the tow store; negligent carding; or too much changing of the sorts from one card to another. Besides, it is injurious to the preparation, from the loss of doublings or overloading of gills, and leads to negligence, and affords an excuse for the passing of numerous singlings, on the part of the back minder.

After the sets are run through the set-frame, the sliver is put up at the back of the third drawing or finisher, and from this over the roving frame.

Tow Preparation.

In tow preparation it is advisable to have no more than a single sliver over each gill, as the drafts are always short; and there may not be too many "heads" in the machines, as the boss-roller needs to be of small diameter to allow of as short a "nip" as possible, and in consequence must be proportionately short to resist the torsional strain. Double slivers, combined with short drafts, would necessitate the frames being driven much above their capabilities, or else render imperative the reduction of the speed of the roving frame about one half, thus nearly doubling the cost of the preparation. Besides, short stapled material, if of dry nature, as most tows, has little strength until twisted; this makes it necessary that the distance between the can and the back-conductor should be as short as possible, therefore, the cans have to lie up to, and close under the low back rails. For the same reason, tow must not be packed into the cans, and thus it is beneficial to have as large a can as possible, in order to reduce to a minimum overflowings and piecings. The only other material difference between Line and Tow drawing and roving frames, is, that as material is to a certain extent benefited by being prepared over "reaches" somewhere about the length of the longest fibres to be prepared: so are tow machinery reaches very short, thus reducing its cost.

Shired Card Sliver.

Sometimes a carding engine may be noticed producing remarkably lumpy and shirey-looking sliver, with frequent dropping of the "ends" at the front of the doffer-roller; or even there may be an entire cessation of delivery. The former peculiarity may be caused by the sticking of one or more of the rollers; by the slipping of the gearing of the feed-rollers; by the sticking of one of the feed-sheets; or by the tow being spread intermittently on the sheets. The latter may result from the knife-belt breaking, causing the tow to lap round the doffer-rollers; or from the stripper-belt giving way, and the tow, in consequence, accumulating on the worker-rollers. It does not take long to set these little matters to rights.

Carding, Quantity of.

As previously remarked, it must not be understood that all tows require two cardings—breaking and finishing—as in no instance, except in the case of rescutched tows; poor hand-scutched tows; bad flax to be converted into tow; or hemp, jute and codilla tows, etc., is there any necessity for double carding. Nearly all mill-scutched tows are sufficiently carded after being put through once. For specialities, as old ropes; flax bands; waste of all sorts; and the very coarsest and dirtiest tows, there are special and very serviceable machines called, variously, teasers; devils; shakers; etc.; which, with the minimum waste, reduce such materials to a fit condition for passing through either breaker or finisher card, or both.

The Top Doffer.

Where the tows are so good as not to require the double carding, but produce too poor a sliver with single carding, it will be found very beneficial to separate the top doffer from the others on the card, and to put back the sliver off this, either to be recarded, or to a coarser count of yarn. The reason of this is that the first doffer roller lifts most of the impure and coarsest fibre.

Carded Results.

We annex the method of carding, and the results of the working of different classes of tow:—

COURTRAI FLAX PLUCKINGS.

108 lbs. to Breaker card		93 lbs. to Finisher card.	
Sliver to finisher	= 93·1 lb.	Sliver to 30's weft	= 54·7 lb.
Waste	= 12·9	Top doffer to 14's „	= 32·1
Loss	= 2·0	Waste	= 5·3
		Loss	= 0·9
13·8 per cent. waste	108·0	6·7 per cent. waste	93·0

DUTCH CODILLA TOW.

224 lbs. to Breaker card		82 lbs. to Finisher card.	
Sliver to finisher	= 81·8 lb.	Top doffer to 14's weft	= 36·9 lb.
Top doffer to 14's weft	= 84·3	Sliver to 30's „	= 32·8
Waste	= 51·9	Waste	= 10·5
Loss	= 6·0	Loss	= 1·8
25·8 per cent. waste	224·0	15·0 per cent. waste	82·0

COURTRAI CODILLA TOW.

214lb. to finisher.	(One carding.)
Sliver to 30's weft	= 99·6lb.
Top doffer to 14's „	= 77·0
Waste	= 33·8
Loss	= 3·6
17·5 per cent. waste	214·0

FLEMISH CODILLA TOW.

218lb. to finisher.	(One carding.)
Sliver to 30's weft	= 89·4lb.
Top doffer to 14's „	= 77·9
Waste	= 46·9
Loss	= 3·8
23·2 per cent. waste	218·0

RESCUTCHED IRISH TOW.

224lb. to finisher.	(One carding.)
Sliver to 30's weft	= 94·0lb.
Top doffer to 14's „	= 77·0
Waste	= 48·2
Loss	= 4·8
23·6 per cent. waste	224·0

MILLED IRISH ROUGHING TOW.

100lb. to finisher.	(One carding.)
Sliver to 20's weft	= 85·0lb.
Waste	= 13·5
Loss	= 1·5
15·0 per cent. waste	100·0

HAND-SCUTCHED IRISH ROUGHING TOW.

200lb. to finisher.	(One carding.)
Sliver to 20's weft	= 164·0lb.
Waste	= 32·5
Loss	= 3·5
18·0 per cent. waste	200·0

GERMAN TOW.

224lb. to finisher.	(One carding.)
Sliver to 20's weft	= 130·4lb.
Waste	= 83·7
Loss	= 9·9
41·7 per cent. waste	224·0

MILLED PERNAU TOW.

100lb. to finisher.	(One carding.)
Sliver to 24's weft	= 80·0lb.
Waste	= 16·0
Loss	= 4·0
20 per cent. waste	100·0

There is nearly as much nicety in mixing the tows to card to the greatest advantage, as there is in mixing the dressed line to spin to the best advantage. If tows of a different nature or texture be carded together, there will be a very unsatisfactory sliver turned out, with every possibility of an increased percentage of waste.

Tow Mixing.

It is a matter of the first consideration that the tow store should be roomy, airy, and well lit, but sheltered from the glare of the sun. It must be cool without being damp, so that large quantities of tow may be stored without risk of mildew, and may keep cool without constant turning over. On the other hand, the store must not be kept too dry, as then there would be too frequent applications to the watering can to keep body and "nature" in those sorts that are being used from "hand to mouth," and consequently have not had time to cool down. If, however, it is not possible to send the tow to the cards in that cool and weighty state in which it will card to the best advantage, a "damper" of the best description is :—one gallon of raw linseed oil, and one stone of washing soda, to fifty gallons of water. About three gallons of this may be applied to each ton of tow.

The piling of the tow should be undertaken with the determination to "sort" it according to size and strength of fibre, without reference to the quality or price of flax it came off; or to its own cost; or the particular tool of the hackling machine it came from. None of these particulars will of necessity either make or mar the quality of the tow.

Strong tows and weak, or coarse and fine, will not card together advantageously. Pernau, Dutch, Courtrai, Irish hand-scutched tow, and most Codilla tows card to best advantage separately. Irish M.S., Bruges, and some of the French tows, as Bernay, Moy, etc., mix very well together, and so does Pernau with the coarser Courtrai and French tows. However, where there is a sufficient number of carding engines, it is best to keep the different classes of tow separate as far as possible, to be carded over cards specially adapted to the peculiarities of each.

Where the mixing is done during the piling in the tow store, it should be done thoroughly, by each sort being built on in thin layers, and to the proper proportion. When this tow is required, the men who carry it to the cards should be instructed to pull it out of the face of the pile, right from top to bottom, as hay is pulled out of the stack, and then it will be thoroughly mixed. The proper mixing of tow is considered of such importance in some establishments that the exact quantity of each sort is weighed into the bulk, and then before it is used, the whole is put through a teazer, merely for the purpose of being thoroughly mixed. The following "Table of Tow Mixes" will give a general idea of the capabilities of the different classes and qualities of tow, but the proportion either of cans in the set, or quantity in the pile of each sort, must be left an open question, the variation both in the price and quality of tow being so great. For finer counts of yarn than here specified, the tow will require to be put through a combing machine. It is advisable to sell those sorts of tow that are being made, but that cannot be spun to advantage; and *vice versa*, to buy such as are not being made at the time, but are much needed for the production of the desired class of yarn.

Table of Tow Mixes.

If the quality of tow be of fair average ; the cards adapted for the work required of them ; and the yarns produced fairly up to standard quality ; the following "average percentage of waste" will be found not wide of the mark. From the great fluctuation in the price of tows, it would be impossible to give a correct idea of the value of the various tows in the following mixes. However, it may be stated that Irish rescutched and most Codilla tows are worth from 20s. to 25s. per cwt. Irish H.S. and H.D. ; Russian ; Friesland ; and such like poor open tows, keep wonderfully together in

TABLE OF TOW MIXES.

Lea.	WARP.	Approximate percentage of Card Waste.	WEFT.	Approximate percentage of Card Waste.
14's	Top Doffer of Coarse Tows	26	Top Doffer of Rescutched Tows	35
16's	Rescutched Tow; and Irish H.S. Roughing; and 1 and 2 Machine Tow	23	Rescutched Tow,	32
18's	Top Doffer of Medium Tows; and Codilla Tows; and Irish M.S. Roughing	21	Rescutched Tow; and Irish H.S. Roughing	30
20's	Dutch; Bruges; and Irish Roughings	19	Pernau and Irish H.S. Roughing	28
22's	Bruges Roughing; and Irish M.S. 1 and 2 Machine Tow.	17	Pernau and Irish M.S. Roughing	26
25's	Courtrai and French Roughing; and Bruges and Dutch 1 and 2 Machine	15	Irish H.S.; and Pernau 1 and 2 Machine Tow,	24
28's	Courtrai 1 and 2 Machine; and Irish M.S. 3 and 4 Machine	14	Irish M.S. 1 and 2 Machine; and Irish H.S. 3 and 4 Machine Tow	22
30's	French 1 and 2 Machine; and Irish and Bruges 3 and 4 Machine	13	Bruges; Dutch; and Irish M.S. 1 and 2 Machine Tow	20
35's	Dutch 3 and 4 Machine; and Irish M.S. Sorting	12	Pernau 3 and 4 Machine; and Irish H.S. Sorting	18
40's	French 3 and 4 Machine Tow; and Irish: Bruges; and Dutch Sorting	11	Pernau and Irish M.S. 3 and 4 Machine Tow	16
45's	Courtrai 3 and 4 Machine; and French Sorting	10	Irish M.S. 3 and 4 Machine; and Pernau Sorting	14
50's	Courtrai Sorting; and Cut Line 1 and 2 Machine	9	Irish M.S. Sorting; and Bruges 3 and 4 Machine	12
55's	Cut Line 3 Machine Tow	8	Irish M.S. Sorting; & Dutch & Courtrai 3 & 4 Machine	11
60's	Cut Line 4 Machine Tow	7	Irish; Dutch; & Bruges Sorting; & Courtrai 3 & 4 Machine	10
65's	Cut Line Sorting Tow	7	Courtrai Sorting Tow	9
70's	Cut Line Sorting Tow	7	Cutline Machine Tow	8

price, at from 30s. to 36s. per cwt. for the roughing, and rising about 2s. per cwt. on each of the machine and sorting numbers. The better class of Irish M.S.; the medium class of Bruges, Dutch, Flemish, and French tows; and the poorer class of Courtrai long line tow; are much the same value, 50s. per cwt. for the roughing, and rising about 4s. per cwt. on the three machine and the sorting numbers, that is on No. 1, No. 2, Nos. 3 and 4 and stg. The superior class of Courtrai long and cut line tows will rise from 4s. to 6s., or 7s., on each number; some of the finest bringing as much as £90 per ton, even before being combed.

Value of Tows.

Light carding, like light spreading of flax is daily growing in favour as being in the long run most economical. Thus, where 20 years ago there was scarcely such a thing known as a two-doffer 5ft. card, there is now seldom a three-doffer one ordered at all; the reason being that the spreading of the tow cannot be so light where it is separated into nine portions in the front, as where there are only six; as a certain body must be kept in these delicate deliveries, or the least draught in the room would "shire" and blow them down. It was common for one of these three doffer cards, of old, to supply material for as many as eight spinning frames, so that about 1,000lb. of tow passed through each card per day; where now it is sufficient if a two-doffer card keeps about three spinning frames supplied with rove, so that sometimes as little as 300lb. is run through per diem.

Light Carding.

Still, however, the body of tow to be passed through the card must be regulated to a great extent by quality. Tows of short, hard, and brittle fibre, give best results when carded pretty heavy, as the fibres then cling better together in the process, and so escape dropping to waste. A large meshed grating, fitting in closely round the bottom rollers and up to the cylinder, is the right thing in the right place, with such fibre. Rollers of small diameter also give best results with fibre of short staple, and as one of the chief desiderata in a card is that the rollers be rigid, when they become very small in diameter, they must also be short. Hence it is that even to this day there is no card better adapted for tows of very short staple than the old-fashioned 3ft. diameter by 4ft. face card, with rollers of proportionately small diameter. These cards throw off very little waste, if they do very little work.

Body in Card.

Three-doffer cards can be converted into two-doffer by the extraction of the top doffer, and filling up the space by an extra pair of rollers, if the original spacing were correct; or the respacing of those already in the card, if they were previously too close. The respacing all round is costly and tedious, taking two mechanics from four to eight weeks to accomplish. However, if the clothing in the interim be renewed where requisite, and the rollers and cylinder trued up, a card previously not worth more than £100, may, with the outlay of say about £80, become nearly as serviceable as a new one, costing well-nigh £300.

Number of Doffer-rollers.

Cards, to work well, have to sit perfectly level. Their weight, the strain of the driving belt, and inequalties in their axle-bearings soon cause the cylinders to run untrue. A levelling and cleaning out of the brasses will generally be effectual. But sometimes, through centrifugal force, or a bad crush, the cylinder may run unevenly on its axles; in such a case the surest and best way is to true it up on its own bearings. This is done by rigging up a slide rest and cutter, on the back stay of the card, and thus converting the latter, for the time being, into a monster lathe. The cylinder, after being stripped of its rollers and clothing, can be made to revolve at a speed of two or three revolutions per minute by a belt from round the driving shaft itself driving an extem-

Lining-up of Card.

pore counter-shaft made out of one of the rollers of the card, resting in the doffer seats. A second belt to pass round this roller, now counter-shaft, and the surface of the cylinder.

Makers of Machinery.

Regarding the manufacture of the machinery itself, it is scarcely necessary to remark that the number of machinists who include the construction of flax and tow preparing and spinning machinery among their specialities, are not few. But we believe we cannot be gainsaid in according the palm, for superior excellence and adaptability, to Lawson & Sons, Hope Works, Leeds, and Combe, Barbour and Combe, Falls Foundry, Belfast. Indeed, in making this assertion, besides our practical experience in the matter, we have the patent fact to substantiate our opinion, of oft repeated exhibition awards and medals won by these two firms for the excellence of their Flax Spinning Machinery.

Then, of the two, Messrs. Lawson and Sons have the most world-wide reputation, and consequently can afford to turn out slightly the cheaper article ; but we believe that the slight advantage they gain over Messrs. Combe, Barbour and Combe, in point of price, they proportionately lose in superiority of finish. Considering the unchallenged excellence of Messrs. Lawson and Sons' machinery, we think we cannot pay a higher, and withal more deserved, compliment to the handiwork of Messrs. Combe, Barbour and Combe.

Cost of Machinery.

Machine makers price most of their preparing machinery at so much per head, according to particulars, the chief item being the length of reach ; roving and spinning frames are priced at so much per spindle, thus, approximately :—

A LONG LINE SYSTEM.

One Spread-board			= £64
1st Drawing, 2 heads	@	£32	= £64
2nd Drawing, 2 ,,	@	£32	= £64
3rd Drawing, 3 ,,	@	£30	= £90
Roving frame 60 spindles	@	£4 10s.	= £270
			£552

A TOW SYSTEM.

One 5 × 6ft. circular Card, with Rotary			= £285
1st Drawing, 2 heads	@	£22	= £44
2nd Drawing, 2 ,,	@	£22	= £44
3rd Drawing, 3 ,,	@	£22	= £66
Roving frame 60 spindles	@	£3 5s.	= £195
			£634

Technical Terms for Card.

The technical terms for the different parts of a carding engine, as per Lawson & Sons' packing list, are as follow :—

Half-round bar, shields and bracket, circular bracket, drawing-head foot, drawing-head brackets, U's, oil pots, sliver-plate bearer, sliver pins, tin covers, rubbers, cross-rails, two caps, doffer blocks, knife blocks, feed-roller chain, feed-board feet, feed-board bracket, trellis cocks, trellis pins, brush cocks, back cocks, screws, cross-bar bolts, crank rod, crank bracket and handle, feed trough, radial arms, strippers, washers, feeders, doffers, doffing knives, sids, bends, stripper-pulley keys, sliver plates, delivery rollers, top pressing rollers, conductors, driving pulleys, brushes, trellissing, cross-bar, cylinder, joints, brass bushes, wood clothing, leather clothing, etc.

Card Change Sheet.

For reference, it is advisable to keep an account of all the card changes ; this list will comprise :

CARD CHANGE SHEET.

No. of Card.	Lea.	Stripper Drum.	Worker Pinion.	Cylinder Pinion.	Card Draft.	Rotary Draft.	Weight of Lap.	Percentage Waste.	Date.
3	40's ×	20″	40	26	15	2	5oz.	14	3/8/76
5	30's	18″	40	40	16	1½	6oz.	17	4/9/76
3	30's	20″	34	34	16	1½	6oz.	18	4/9/76
10	60's ×	16″	24	48	15	1½	3½oz.	10	7/9/76

Carders' Wages.

The rate of wages in the carding department has ruled very similar to that of the line department, carders, however, being slightly in advance of flax-spreaders. This is mainly due, not to the fact of the work of the former being more unhealthy, but to this: that they are liable to weighty fines on their card becoming damaged in any way.

Operatives' Charge.

The extent of charge devolving on the operatives in the flax and tow preparing departments must principally depend, in the case of spreaders and carders, upon the piecing-out and speeds; in that of drawers, upon drafts and speeds; and in the case of rovers, upon speeds. A spreader may be quite as much occupied in minding two belts, or leathers, of a coarse four-belt spread-board, as she would be with spreading all the belts of a six-belt, finer machine. A tow drawer may have as much to do in minding two drawing-frame fronts and one roving-frame back as a line drawer with four drawing-frame fronts and one and a half roving-frame backs; a tow back-minder, with three drawing-frame backs, as a line backminder with seven, etc., etc. Rovers generally mind two roving frames, coarse or fine; but where these are placed facing each other, in two parallel rows up the centre of the room, a girl can take charge of two frames on one side, and one on the other, and yet have all the spindles under her eye.

Particulars of Cards.

With fullest particulars of carding engines and tow preparing machinery of the newest and most approved make, thoroughly adapted for all classes of tow, from the coarsest to the finest, we conclude our remarks on tow preparing. If there be rotary drawing heads attached to the cards, their particulars may be somewhat as follow:—Three slivers, pitch of boss 7 inch, conductors (shiftable) 2¾ and 3½ inch, breadth of gill 4 inch, length of pin—out of stock—¾ inch and ½ inch, two rows, wire gauge 15 and 16, pins per inch 5.

Particulars of Rotary.

Particulars of a Breaker Card, for opening soft band and ropes; scutchihg tows; codilla and other pluckings and combings; hemp; jute; etc., and also all fibrous waste.

	Diameter Unclothed.	Description of Clothing.	Length of Pin over Clothing.	Wire Gauge.	Pins per square inch.	Set to Cylinder.	Set to Stripper.
	In.		In.				
Cylinder	60	Staves	$\frac{3}{8}$	10	2	..	..
Top Feed Roller	3	Porcupine (brass)	$\frac{5}{8}$	10	6	12	..
Bottom Feed Roller	3	,, ,,	$\frac{5}{8}$	10	6	7	12
Feed Stripper	12	Staves	$\frac{1}{2}$	11	6	12	..
1st Stripper	11	,,	$\frac{1}{2}$	11	6	13	..
1st Worker	9	Filleting	$\frac{1}{2}$	10	4	10	13
2nd Stripper	11	Staves	$\frac{1}{2}$	12	8	14	..
2nd Worker	9	Filleting	$\frac{1}{2}$	11	6	11	14
3rd Stripper	11	Staves	$\frac{1}{2}$	13	10	15	..
3rd Worker	9	Filleting or Staves	$\frac{1}{2}$	12	8	12	15
4th Stripper	11	,, ,,	$\frac{1}{2}$	14	12	16	..
4th Worker	9	,, ,,	$\frac{1}{2}$	13	10	13	16
1st Doffer	14	,, ,,	$\frac{7}{16}$	14	15	13	..
2nd Doffer	14	,, ,,	$\frac{7}{16}$	15	18	14	..

Particulars of a coarse 5 × 6 feet Breaker and Finisher Card, for from 10's to 18's lea, with from 9oz. to 6oz. lap; area of same 22in. × 28in. Draft, 14.

Rollers.	Diameter Unclothed.	Description of Clothing.	Length of Pin over Clothing.	Wire Gauge.	Pins per square inch.	Set to Cylinder.	Set to Stripper.
	In.		In.				
Cylinder	60	Staves	$\frac{3}{8}$	16	12	..	..
Top Feed	$2\frac{3}{4}$	Porcupine (brass)	$\frac{3}{8}$	13	10	15	..
Bottom Feed	$2\frac{3}{4}$	,, ,,	$\frac{3}{8}$	13	10	9	14
Feed Stripper	10	Staves	$\frac{1}{2}$	13	10	13	..
1st Stripper	10	Staves	$\frac{7}{16}$	14	15	14	..
1st Worker	8	Filleting	$\frac{1}{2}$	13	8	11	14
2nd Stripper	10	Staves	$\frac{7}{16}$	14	15	15	..
2nd Worker	8	Filleting	$\frac{1}{2}$	13	10	12	16
3rd Stripper	10	Staves	$\frac{7}{16}$	15	18	15	..
3rd Worker	8	Filleting or Staves	$\frac{1}{2}$	14	12	12	16
4th Stripper	10	,, ,,	$\frac{7}{16}$	15	18	15	..
4th Worker	8	,, ,,	$\frac{1}{2}$	14	15	12	16
5th Stripper	10	,, ,,	$\frac{7}{16}$	16	21	16	..
5th Worker	8	,, ,,	$\frac{1}{2}$	15	18	13	16
1st Doffer	14	,, ,,	$\frac{1}{2}$	15	18	14	..
2nd Doffer	14	,, ,,	$\frac{1}{2}$	16	21	15	..
3rd Doffer	14	,, ,,	$\frac{1}{2}$	17	24	16	..

Particulars of a coarse 5 × 6 feet Breaker and Finisher Card, for from 14's to 25's lea, with from 7oz. to 4½ oz. lap; area of same, 22″ × 28″. Draft, 13.

Rollers.	Diameter Unclothed.	Description of Clothing.	Length of Pin over Clothing.	Wire Guage.	Pins per square inch.	Set to Cylinder.	Set to Stripper.
	In.		In.				
Cylinder	60	Staves	5/16	17	18	..	..
Top Feed	2½	Porcupine (brass)	9/16	14	12	16	..
Bottom Feed	2½	,, ,,	9/16	14	12	10	16
Feed Stripper	9	Staves	7/16	14	12	14	..
1st Stripper	9	,,	3/8	15	15	15	..
1st Worker	7	Filleting	7/16	14	12	12	16
2nd Stripper	9	Staves	3/8	15	18	16	..
2nd Worker	7	Filleting	7/16	14	15	13	18
3rd Stripper	9	Staves	3/8	17	21	16	..
3rd Worker	7	Filleting or Staves	7/16	15	15	13	18
4th Stripper	9	,, ,,	3/8	17	24	16	..
4th Worker	7	,, ,,	7/16	15	18	13	18
5th Stripper	9	,, ,,	3/8	18	28	18	..
5th Worker	7	,, ,,	7/16	17	21	14	18
6th Stripper	9	,, ,,	3/8	18	32	18	..
6th Worker	7	,, ,,	7/16	17	24	14	18
1st Doffer	14	,, ,,	7/16	17	24	16	..
2nd Doffer	14	,, ,,	7/16	18	32	17	..

Particulars of a Medium 5 × 6 feet Breaker and Finisher Card, for from 25's to 35's lea, with from 5oz. to 3½oz. lap; area of same, 22″ × 28″. Draft, 14.

Rollers.	Diameter Unclothed.	Description of Clothing.	Length of Pin over Clothing.	Wire Gauge.	Pins per square inch.	Set to Cylinder.	Set to Stripper.
	In.		In.				
Cylinder	60	Staves	¼	18	24	..	..
Top Feed	2½	Porcupine (brass)	½	14	15	17	..
Bottom Feed	2½	,, ,,	½	14	15	11	18
Feed Stripper	8	Staves	3/8	16	18	17	..
1st Stripper	7	,,	5/16	16	21	18	..
1st Worker	6	Filleting	3/8	15	18	15	20
2nd Stripper	7	Staves	5/16	17	24	18	..
2nd Worker	6	Filleting	3/8	16	21	15	20
3rd Stripper	7	Staves	5/16	17	27	18	..
3rd Worker	6	Filleting or Staves	3/8	16	24	15	20
4th Stripper	7	,, ,,	5/16	18	32	18	..
4th Worker	6	,, ,,	3/8	17	24	15	20
5th Stripper	7	,, ,,	5/16	18	36	18	..
5th Worker	6	,, ,,	3/8	17	27	15	20
6th Stripper	7	,, ,,	5/16	19	36	18	..
6th Worker	6	,, ,,	3/8	18	32	15	20
7th Stripper	7	,, ,,	5/16	19	40	18	..
7th Worker	6	,, ,,	3/8	18	36	15	20
1st Doffer	14	,, ,,	3/8	18	32	16	..
2nd Doffer	14	,, ,,	3/8	19	40	18	..

Particulars of a Fine 6 feet Face Breaker and Finisher Card, for from 40's to 70's lea, with from 4oz. to 2½oz. lap; area, 22″ × 28″. Draft, 15.

Rollers.	Diameter Unclothed.	Description of Clothing.	Length of Pin over Clothing.	Wire Gauge.	Pins per square inch.	Set to Cylinder.	Set to Stripper.
	In.						
Cylinder	60	Filleting or Staves ..	$\frac{7}{32}$	19	36	..	..
Top Feed Roller	2¼	Porcupine (brass)....	½	15	18	18	..
Bottom Feed Roller	2¼	Filleting or Staves ..	½	15	18	12	20
Feed Stripper	6	,, ,, ..	$\frac{5}{16}$	16	18	18	..
1st Stripper	5½	,, ,, ..	¼	16	21	18	..
1st Worker	4½	,, ,, ..	$\frac{5}{16}$	15	15	14	20
2nd Stripper	5½	,, ,, ..	¼	16	24	20	..
2nd Worker	4½	,, ,, ..	$\frac{5}{16}$	16	18	17	21
3rd Stripper	5½	,, ,, ..	¼	17	24	20	..
3rd Worker	4½	,, ,, ..	$\frac{5}{16}$	16	21	17	21
4th Stripper	5½	,, ,, ..	¼	17	27	20	..
4th Worker	4½	,, ,, ..	$\frac{5}{16}$	17	21	17	21
5th Stripper	5½	,, ,, ..	¼	19	36	20	..
5th Worker	4½	,, ,, ..	$\frac{5}{16}$	17	24	17	21
6th Stripper	5½	,, ,, ..	¼	19	40	20	..
6th Worker	4½	,, ,, ..	$\frac{5}{16}$	18	28	17	21
7th Stripper	5½	,, ,, ..	¼	20	45	20	..
7th Worker	4½	,, ..	$\frac{5}{16}$	18	32	17	21
8th Stripper	5½	,, ,, ..	¼	20	50	20	..
8th Worker	4½	,, ,, ..	$\frac{5}{16}$	20	45	17	21
9th Stripper	5½	,, ,, ..	¼	22	60	20	..
9th Worker	4½	,, ,, ..	$\frac{5}{16}$	20	50	17	21
1st Doffer	14	,, ,, ..	$\frac{5}{16}$	20	45	17	..
2nd Doffer	14	,, ,, ..	$\frac{5}{16}$	22	60	19	..

Particulars of a Cut Line 6 feet Face Finisher Card, for from 70's lea and upwards, with from 3½oz. to 2oz. lap. Draft, 12.

Rollers.	Diameter Unclothed.	Description of Clothing.	Length of Pin over Clothing.	Wire Gauge.	Pins per square inch.	Set to Cylinder.	Set to Stripper.
	In.		In.				
Cylinder	60	Filleting or Staves ..	$\frac{3}{16}$	19	48	..	..
Top Feed Roller	2¼	Porcupine (brass)....	$\frac{7}{16}$	15	18	19	..
Bottom Feed Roller	2¼	,, ,, ...	$\frac{7}{16}$	15	18	13	22
Feed Stripper	5	Filleting or Staves ..	¼	17	21	20	..
1st Stripper	4½	,, ,, ..	$\frac{3}{16}$	18	28	20	..
1st Worker	3½	,, ,, ..	¼	17	21	15	22
2nd Stripper	4½	,, ,, ..	$\frac{3}{16}$	18	32	22	..
2nd Worker	3½	,, ,, ..	¼	17	24	19	22
3rd Stripper	4½	,, ,, ..	$\frac{3}{16}$	19	36	22	..
3rd Worker	3½	,, ,, ..	¼	18	28	19	22
4th Stripper	4½	,, ,, ..	$\frac{3}{16}$	19	40	22	..
4th Worker	3½	,, ,, ..	¼	18	32	19	22
5th Stripper	4½	,, ,, ..	$\frac{3}{16}$	20	45	22	..
5th Worker	3½	,, ,, ..	¼	19	36	19	22
6th Stripper	4½	,, ,, ..	$\frac{3}{16}$	20	50	22	..
6th Worker	3½	,, ,, ..	¼	19	40	19	22
7th Stripper	4½	,, ,, ..	$\frac{3}{16}$	22	52	22	..
7th Worker	3½	,, ,, ..	¼	21	55	19	22
8th Stripper	4½	,, ,, ..	$\frac{3}{16}$	22	70	22	..
8th Worker	3½	,, ,, ..	¼	21	60	19	22
9th Stripper	4½	,, ,, ..	$\frac{3}{16}$	24	96	22	..
9th Worker	3½	,, ,, ..	¼	23	78	19	22
10th Stripper	4½	,, ,, ..	$\frac{3}{16}$	24	102	22	..
10th Worker	3½	,, ,, ..	¼	23	84	19	22
1st Doffer	14	,, ,, ..	¼	23	84	18	..
2nd Doffer	14	,, ,, ..	¼	24	102	20	...

PARTICULARS OF TOW PREPARING MACHINERY.

Coarse Tow System, for from 8's to 18's Lea = 25 to 50 yards per ounce. Length of Bell, 400 yards.

Description of Frame.	Heads per Frame	Rows per Head.	Deliveries per Head.	Sliver per Delivery.	L'ngth of Reach.	Brd'th of Gill.	Brd'th of Conductor.	Length of Pin.	Pins per Inch.	Rows per Stock.	Wire Gauge.	Pitch of Screw.	Pitch of Boss.	Boss Roller Dia.	Sp'ndle Blade Dia.	Traverse of Bobbin.	Can Dia.	Pressure on Roller.	Draft on Frame.	Bobbin Head Dia.
					in.	in.	in.	in.				in.	in.	in.	in.	in.	in.			in.
Card, 3 Doffer..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	13	..
Bell Frame	2	6	1	6	12	3½	2¾	1¾	8	2	15	½	6	2¼	..	..	13	600	7 to 9	..
Set Frame	3	8	1	8	11	2½	2	1½	9	2	16	½	4¼	2¼	..	..	10	500	8 to 10	..
Finisher	3	8	2	4	10	2	1½	1¼	11	2	17	7/16	3½	1¾	..	..	9	400	7 to 9	..
Roving	6	10	10	1	10	1⅝	9/16	1	13	2	18	7/16	3¼	2	15/16	8	..	300	8 to 11	4¼

Medium Tow System, for from 20's to 35's Lea = 40 to 70 yards per ounce. Length of Bell, 500 yards.

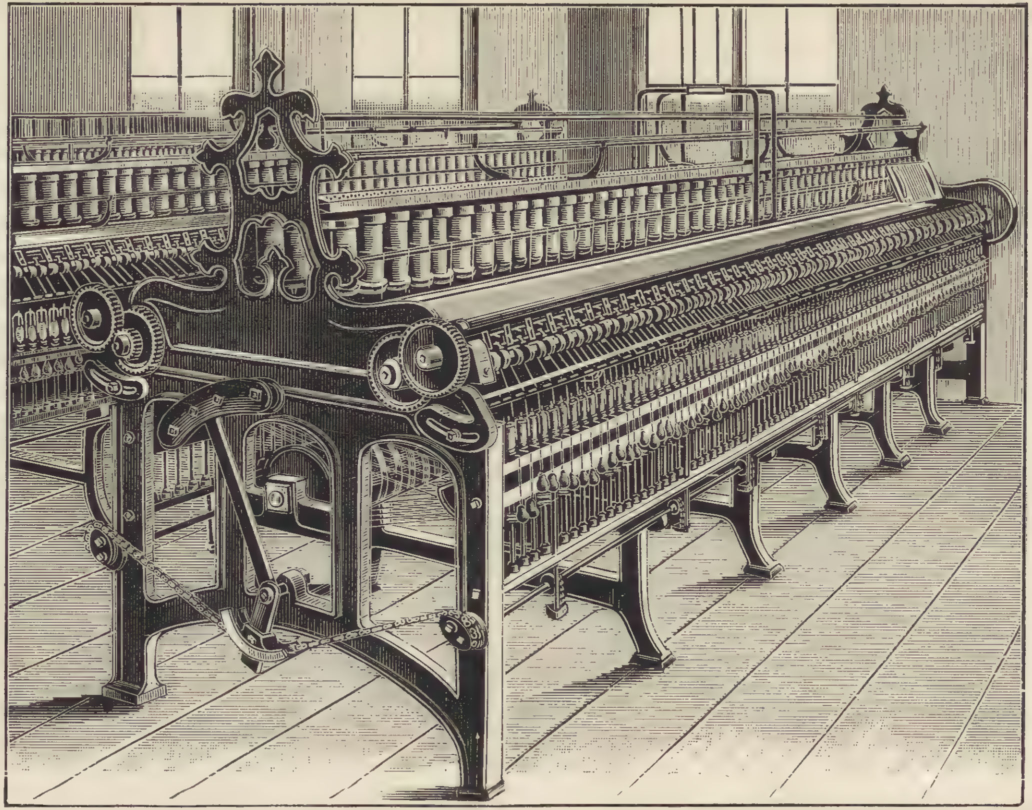
Description of Frame.	Heads per Frame	Rows per Head.	Deliveries per Head.	Sliver per Delivery.	L'ngth of Reach.	Brd'th of Gill.	Brd'th of Conductor.	Length of Pin.	Pins per Inch.	Rows per Stock.	Wire Gauge.	Pitch of Screw.	Pitch of Boss.	Boss Roller Dia.	Sp'ndle Blade Dia.	Traverse of Bobbin.	Can Dia.	Pressure on Roller.	Draft on Frame.	Bobbin Head Dia.
Card, 2 Doffer..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	14	..
Bell Frame	2	8	1	8	11	2¾	2	1¼	10	2	17	½	4½	2¼	..	..	12	500	9 to 11	..
Set Frame	3	8	1	8	11	2¼	1½	1⅛	12	2	18	7/16	3¾	2	..	..	10	400	9 to 11	..
Finisher	3	8	2	4	10	1¾	1	1	14	2	19	7/16	3	1¾	..	..	9	300	7 to 9	..
Roving	6	10	10	1	9	1¼	½	⅞	16	2	20	⅜	2¾	1¾	13/16	8	..	250	8 to 11	3¾

Fine Tow System, for from 40's to 80's Lea = 60 to 100 yards per ounce. Length of Bell, 700 yards.

Description of Frame.	Heads per Frame	Rows per Head.	Deliveries per Head.	Sliver per Delivery.	L'ngth of Reach.	Brd'th of Gill.	Brd'th of Conductor.	Length of Pin.	Pins per Inch.	Rows per Stock.	Wire Gauge.	Pitch of Screw.	Pitch of Boss.	Boss Roller Dia.	Sp'ndle Blade Dia.	Traverse of Bobbin.	Can Dia.	Pressure on Roller.	Draft on Frame.	Bobbin Head Dia.
Card, 2 Doffer..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	15	..
Bell Frame	3	8	1	8	11	2½	1½	1⅛	12	2	18	½	4¼	2	..	..	10	450	9 to 11	..
Set Frame	3	8	1	8	10	2	1¼	1	15	2	20	7/16	3½	1¾	..	..	9	400	9 to 11	..
Finisher	3	12	2	6	9	1½	¾	⅞	18	2	22	7/16	2½	1⅝	..	..	8	300	8 to 10	..
Roving	7	10	10	1	9	1	⅜	¾	21	2	24	5/16	2½	1⅜	¾	8	..	200	9 to 11	3

PART IV.

SPINNING DEPARTMENT.



SPINNING FRAME.

CHAPTER XIV.

THE SPINNING FRAME.

Spinning Room.

WE now pass to a description of the Spinning Room, where the rove is spun into yarn. This process is nearly entirely mechanical, brass rollers, fluted and revolving, taking the place of the primitive rock and manipulation between the fingers, as practised with the spinning wheel. The fact of spinning, as it now is, being mechanical, cannot be better illustrated than by mentioning, that, as much yarn can now be spun under the supervision of one woman, called a spinner, as could be turned off 400 spinning wheels by 400 women in olden times.

Spinners' Stand.

The modern spinning room is generally large, and well lit, but very hot, from the fact of boiling water being necessary to the requisite maceration of the fibre, where levelness is the desideratum. A spinning room may be any length, according to the number of frames to sit in it, and should be about 45ft. or 46ft. broad, to allow two frames of about 20ft. in length each, to sit across the room, and to leave plenty of space between them for a roomy "pass," and for freedom to clean and oil the ends of the frames. The windows should be spaced to allow of one being between each frame, so that there may be a good light shining down the sides of each, that the spinner may see her "ends," that is, the different threads of yarn. The frames should also be kept pretty far apart—say, 4ft., so that there may be room as well as light. The division thus formed is called a stand.

Structure of Spinning Frame.

A spinning frame is oblong in shape ; it is built on a structure of supports or gables, standing transversely to the sides, two or three feet apart. The sides are mainly composed of two horizontal rows of rails, parallel, and one over the other, which bind the gables together with the aid of the beam of the frame. This beam is also horizontal, and parallel to and above the rails, but slightly set backwards from them, thus completing the framework of the machine. But the rails and beams have other purposes to fulfil besides forming the framework. The first form the supports for the vertical spindles, which revolve at great speed and on each side of the frame, the spindle foot working in a brass bush, called the spindle step, inserted in the lower rail ; and the spindle neck, working in a brass bush, called the neck, set in the upper rail. It is to the upper, or beam, portion of the frame that the stands are attached, in which, with the aid of the saddle and spring wire, the top and bottom pressing rollers are contained. Running parallel to the two sets of rails, and between them, in the heart of the frame, is the cylinder, made of tin, the full length of the frame, and about 10in. in diameter, with iron axles bearing on seats, cast in the centre of the two end gables. Bands, usually of cotton cord, pass round this cylinder, and thence to the spindles. On the butt of these latter, between the rails, is firmly driven a small grooved iron boss, commonly called the wharve, and as the bands are firmly tied round these, so is the immense surface speed of the cylinder communicated to the spindles.

Spindle and Flyer.

The spindles thus acquire a velocity of thousands of revolutions per minute, which enables the yarn, as it passes through the eye of a flyer, screwed on to the top of each spindle, to be properly twisted before it is wound on to the bobbin. This latter revolves on the spindle, and under the flyer.

One end of the cylinder axle is extended or continued out for about 18 inches, so as to allow of a small wheel being keyed on, outside the bearing. This wheel is called the "cylinder pinion," and it gives motion to the rest of the gearing in a manner soon to be described.

Driving of Spinning Frame.

The means by which the cylinder, and consequently the cylinder pinion, receives its motion is thus:—A plane-faced wheel, called a pulley, is keyed on to the elongated axle of the cylinder, outside the cylinder pinion. This pulley is connected with the driving shaft of the room, by a leather strap or belt, which passes round its face and round that of a larger plane wheel, called a "drum," keyed on to the driving shaft. It is evident that so long as the driving shaft is revolving, and the belt remains on the keyed pulley of the machine, so long does that machine remain in motion. But the frame can be instantly stopped, at any time, by the running belt being guided—by means of the belt-fork or handle—from the tight pulley, to the face of one running free, or loose, close alongside.

The spindles already referred to may be any length from 12 to 24 inches from top to foot, according to the lea of the yarn to be twisted; and the upper and lower rails are proportionately apart. The upper portion of the spindle which rises clear of the upper rail, or spindle "neck," is known as the spindle "blade."

Builders of Spinning Frame.

Over the spindle blades are let down the "builders," which are simply trays or dishes of iron, each about six feet in length by six inches broad, perforated so that they may work up and down freely over the spindle blades without bearing against them. These builders are wrought in the following way: They rest upon builder rods, which are attached at the lower end to a horizontal shaft, called the builder shaft. This has a cam attached to its end, which is connected by a chain with a lever and quadrant that rotate upon a stud screwed into the gable of the frame. The quadrant is lined with a row of teeth or pins, encased in a slot or groove. This groove is utilised as a guide, in which a small toothed pinion, on the end of the builder pinion shaft, travels, and at the same time compresses the teeth of the pinion and quadrant together. As the pinion revolves on one point, and the quadrant upon a stud, the pinion draws the quadrant backwards and forwards each time it travels to the end of the slotted chamber, by having to follow the curve which changes the pinion from the upper to the under side of the teeth in the quadrant, and *vice versa*, thus producing a continuous and regular rotating motion. The builder chains, which are brought over the cams on the builder shaft, are connected to the end of the lever that projects from the opposite side of the quadrant fulcrum; and in this manner is the even rise and fall of the builders regulated; the distance that they travel, or, as it is called, the traverse, being arranged by either shortening or lengthening the builder-chains by means of nuts and screws. The bobbins, on which the yarn is wound after being spun, are placed over the spindles dropping down until they rest upon the builder, after which the flyers are screwed upon the spindle top. The flyers are simply two legs of steel projecting from the boss or socket, that fits down on the spindle top. These legs are widened so as to permit the bobbins to work freely up and down inside them, and thus, when the builder raises the bobbins up as far as the head of the flyer, the latter may be lapping the end of the yarn round the bottom portion of the barrel of bobbin; and as the builder slowly descends with the bobbins on it, the yarn is lapped evenly round the bobbin to the top.

Size of Spindle.

From this explanation it will be seen that the spindle blade must be more than double the length of traverse, so that if a long traverse be required it will be necessary to have a strong

heavy blade, and the other portions of the spindle stout in proportion. This of itself will prevent the over-driving of the spindle to any great extent, as a long heavy spindle cannot be driven at the same speed as a short light one. A strong spindle blade necessitates a bobbin with a large bore, which means a large barrel, as, if the barrel be too light the bobbin won't last; and a large barrel a large head, or else the doffing will be so frequent that it will greatly diminish the production of yarn, and increase the wear and tear of the bobbins and spindles.

It will thus be seen that there are a great many points to be considered in the correct proportioning of a spinning frame, and the writer will now proceed to lay before his readers some rules which will be found useful in deciding questions that are being continually agitated, as:—What is lightest spindle blade, in proportion to length of same, consistent with rigidity and steadiness? Whether is a long or a short distance between the rails preferable? etc. etc.

Proportions of Spindle.

As regards the size of spindle blade; the smaller its diameter the smaller can the spindle itself be, thus admitting of its being driven at higher speed without vibration; and also allowing of the building of more yarn on the same size—as regards diameter of head—of bobbin.

The requisite distance between the rails is debateable on these heads:—With a long distance between the rails, the spindle is less likely to be top heavy; and the spindle neck will not be so much heated by the friction of the band on the wharve; as the latter can be placed at a greater distance from the neck. With a short distance between the rails, the spindles can be made shorter, and are in consequence more rigid, and can therefore be driven at greater velocity.

To such extremes have these two opinions been carried that in many concerns the spindle "butt" (distance between the rails) is about two-thirds the over-all length of spindle; whilst in others, it does not reach the proportion of one-third.

Pitch of Frame.

To arrive at a true solution of these problems there must be a certain invariable standard to start from. This standard is the "pitch" of the frame, *i.e.*, the distance between the spindles, or the bosses of the delivering roller.

Traverse of Frame.

Then to state the rule:—Let the traverse of the frame be the same as the pitch, when the quality of the yarn to be spun is wefty, and therefore not requiring so much twist; and let it be a quarter of an inch shorter than the pitch, when the yarn to be spun is of warpy nature. Then regulate the diameter of the spindle blade according to the traverse, as follows:—

Diameters of Spindles.	3in.	$2\frac{3}{4}$in.	$2\frac{1}{2}$in.	$2\frac{1}{4}$in.	2in.	$1\frac{3}{4}$in.	$1\frac{1}{2}$in.	Traverse.
	$\frac{5}{12}$in.	$\frac{4}{10}$in.	$\frac{3}{8}$in.	$\frac{4}{12}$in.	$\frac{9}{32}$in	$\frac{1}{4}$in.	$\frac{7}{32}$in.	Spindle Blade dia.

The proportional diameters of the "neck" and "butt" of the spindle, are got by adding about one-twelfth of an inch to the blade diameter, for the neck; and about one-eighth of an inch to the neck diameter, for the size of butt.

Lengths of Spindle.

As regards the most appropriate lengths for the spindle, in conjunction with the above sizes or diameters; these are found: when the traverse is the same length as the pitch, by multiplying the latter by 2·5, to find the "length of blade" from shoulder to neck. The length of blade divided by two, gives the proportionate length for neck; and the sum of the length of blade and neck is the proper length for the butt of that spindle to be. For a spindle thus proportioned, the best position for the wharve is on the balance point of the spindle.

When the traverse is one quarter of an inch shorter than the pitch, this simple rule also applies, with the single exception of including the spindle top in the length of blade; thus getting the extreme length of blade, and therefrom the over-all length of spindle. For a spindle proportioned in this manner, the best position for the wharve is on the balance point of spindle with warp flyer on.

The spindle "foot," the base of the spindle which revolves in the spindle step, should, in all cases, be the same diameter as the blade of the spindle. Example:—

2¾in. Traverse.	2½in. Traverse.
2·75in. Pitch.	2·75in. Pitch.
2·5	2·5
6·9in.=Blade from shoulder.	6·9in.=Blade from top.
3·4in.=Neck.	3·4in.=Neck.
10·3in.=Butt and foot.	10·3in.=Butt and foot.
20·6in.=Shoulder to foot.	20·6in.=over all length of spindle.
1·0in.=Spindle top.	
21·6in.=Over all length of spindle.	

Roller, to Flyer-eye.

Lastly, the proper distance between the nip of bottom roller and the flyer eye is the length of the spindle butt and foot, of that frame, that is half the length of the spindle.

Shape of Wharve.

There is a nicety in having the V or groove of wharve the proper shape and depth, as, if the groove be too deep the band may become too slack to drive the spindle up to its speed, before it drop off, and so the yarn will not get its proper twist; but if it be too shallow there will be unnecessary waste of band cord and loss of turn off, by the bands dropping off quicker than they can be kept on. A fair intermediate course to pursue is to make the groove an angle of 100 degrees to a well-graduated depth of wharve; and to keep the sides of the angle perfectly straight lines, which is found to be productive of far less friction with the band, than if they are either shouldered or hollowed out.

The Drag-band.

There is no driving power required for the bobbins, as the end of yarn, being carried round by the flyer, is strong enough to pull the bobbin round too. To retard the motion of the bobbin, in order that the yarn may be built firmly on it, there are drag-bands, made out of the old cylinder bands, attached to the back rail of the builder, just behind the spindle. These bands bear upon the base of the bobbin, and fall over the front of the builder, where there hangs a small drag-weight attached to the band. Thus there may be a certain amount of tension on it, which can be either increased or diminished as the bobbin gets fuller and gains centrifugal force, or is empty and loses; by the band being placed a nick or two farther forward, or back, upon the comb of the front rail. Nearly the whole secret of successful spinning, as regards keeping the ends up, is, for the spinner to know how to regulate her drags properly, according to the strength of the yarn and its lea, and the degree of fulness of the bobbin. But, besides this old and homely method of dragging the ends, there are various other ways of doing so, one of which, being the most recent, we will notice, by inserting an extract from the description of the Exhibition held in Belfast, as given in the *News Letter* of that town of the 3rd June, 1876: "Visitors will find the block of machinery which illustrates the different operations in the manufacture of flax, specially interesting. On the spinning frame, they will have an opportunity of observing a novel and valuable invention of Mr. H. M. Girdwood, of Belfast, which is termed the patent self-acting spring-drag motion, which does away with the cord and weight, and by a very simple and ingenious arrangement, makes the dragging of the bobbins automatic, keeping the

necessary tension on each thread during the whole time the bobbins are being filled. For this purpose Mr. Girdwood uses a peculiar angle-shaped metal-rod, which reaches along the front of the bobbin builder, and runs in small U-shaped brackets fastened to the lifter. To this rod springs are fastened, one for each bobbin, the sliding rod being perforated to allow the arms of the springs, which press against the bobbin, to pass through. One end of the sliding-rod is provided with a rack, which is operated on by a worm fastened on a spindle with a ratchet wheel, and this rachet wheel is moved round one tooth each time the bobbin lifter rises or falls, by its coming in contact with a pin, which is fastened to the framing of the machines. When changing from one number of yarn to another, it is only necessary to change the rachet wheel instead of changing all the drag weights, as was formerly the case, and caused considerable loss. There is also this to be observed, that the attendant has much less work, as she has to pay no attention whatever to the dragging of the bobbins. There is no waste caused by threads breaking from want of tension, and when the full bobbins are taken off the frame, and empty ones put on, which process is called doffing, the proper tension is at once applied to each thread, which, with the old arrangement, was a most troublesome and wasteful operation.

"It is also to be remarked that when the bobbins are full, if a full one be taken off the spindle and an empty one put on in its place, the thread will be taken upon the empty one with no perceptible increase in the tension of the yarn. This shows that there is great give-and-take in the spring, which enables it to accommodate itself to any variation caused by differences in bobbins. The lubricating of the machine is also facilitated and much oil saved.

" The patent drag has other advantages, which will readily suggest themselves to observers who have a practical knowledge of the machinery."

The Thread Plates. A couple or more of inches above the top of the spindle are the thread plates, which are a row of horizontal iron plates working on swivels attached to brackets screwed to the framework. These plates are made of about $\frac{1}{4}$in. cast iron, four inches broad. They are nearly at right angles to the spindle, and are parallel to the beam and rails. In the plates holes are bored plumb with the spindle-top ; these are bushed with brass bushions, which latter have a fine hole bored through them, called the thread-plate eye. These eyes are opened out to the front of the plates by a diagonal slit cut through the front of the plate and the brass bushion into them.

The thread of yarn has to pass through this eye, as it comes from the nip of the bottom or boss roller, some three or four inches above ; and it then passes over the shoulder of the flyer, and through its eye, on to the bobbin.

Creel and Trough. The rove out of which this thread of yarn has been spun, had first to be drawn through hot water, contained in a shallow wooden trough, the length of the frame, situated between the creel which holds the bobbins of rove, and the rollers that draw it through the water : the hot water is necessary to the proper maceration of the fibre, before being drafted and spun. The rove on emerging from the trough, passes into a guide, called the rove-shifter, and thence into the roller that draws it in, called the top or feed roller. **Brass Rollers.** This roller, and also the one that draws or drafts the rove from it, is of iron, covered with brass bosses fluted horizontally. Compressed by leverage against the face of the bosses of these two rollers, are small two-boss pressing rollers of wood, with flutes similar to those of the brass bosses.

Thus is the rove held as in a vice in the flutes of the top and bottom rollers ; but as the latter is revolving with, say, ten times the surface

velocity of the former, so is the rove between them drawn out or drafted very fine, before it is delivered from the nip of the bottom roller to receive the twist from the spindle, to give it the requisite strength.

Gear of Spinning-frame.

To trace how these rollers can be made to revolve so as to give any desired draft and twist to the yarn, we must again refer to the cylinder on the end of which there is a pinion. This cylinder pinion is in gear with a large wheel on a stud, called the crown wheel. The boss of the socket of this wheel is produced as well as the stud on which the socket turns, and so room is found to key a wheel on the socket. This wheel is called the twist wheel, as the changing of it changes the speed of the fluted rollers; and therefore, as the delivery is increased or diminished, the speed of spindle being unaltered, the yarn receives the less or more twist.

The twist is in gear with a large intermediate, which again is in gear with a wheel on the end of the bottom roller, called the roller wheel. On the other end of the bottom roller is a small pinion called the roller-pinion. This in gear with a wheel on a stud, called the stud wheel, and on the socket of this stud wheel produced, is a wheel called the draft or change pinion, as it is by the altering of this wheel that the speed of the top roller may be increased or diminished so as to shorten or lengthen the draft.

The draft pinion is in gear with the top roller wheel, which completes the system of gearing of a spinning frame, except that the builder pinion shaft is wrought by a retarded train of gearing taken from the large intermediate before mentioned.

Having described the system of gearing, we will now have a look at the relative speeds of the spinning frame.

Spinning-frame Calculations.

	240	revolutions of driving shaft per minute.
	22in.	dia. of driving drum.
Pulley dia. 13in.)	5280	
	406·15	revolutions of cylinder, circum. 28¼in.
	27	cylinder pinion.
Crown wheel........... 160·00)	10966·05	
	68·54	revolutions of crown wheel.
	46	twist wheel.
Roller wheel .... 100·00)	3152·84	
	31·53	revol. of bottom roller, dia. 1¾in., 36 flutes.
	30	bottom roller pinion.
Stud wheel................ 90·00)	945·90	
	10·51	
	38	draft pinion.
Top roller wheel... ...... 108·00)	399·38	
	3·69	revol. of top roller, dia. 1⅛in., 32 flutes.
	3·86in.	circumference top roller (dia. × 3·43 = cir.)
	14·24	inches received.

	31·53	revolutions of bottom roller.
(Dia. × 3·43) =	6·00	circumference of bottom roller.
14·24)	189·18	
	13·28	draft.
	38	draft pinion.
	504	constant number for draft.

	406·15	revolutions of cylinder.
	28·25	inches circumference.
Wharf cir.	2·89in.)11473·74	
Delivered	189·18in.)3970·14	revolutions of spindle per minute.
	20·98	turns per inch twist.
	46	twist wheel.
	965	constant number for twist.

Having glanced at the relative speeds of a spinning frame, we will now (as before explained in one of the chapters on preparing) pick out from the preceding those wheels that are sufficient for the speedy working out of the constant numbers for draft and twist.

DRAFT.

$$\frac{90 \times 108 \times 1\frac{3}{4}\text{in.}}{30 \times - \times 1\frac{1}{8}\text{in.}} = 504 \text{ Constant No. Draft.}$$

Names of Wheels.

$$\frac{\text{Stud wheel} \times \text{Top roller wheel} \times \text{Bottom roller diameter.}}{\text{Bottom roller pinion} \times - \times \text{Top roller diameter.}}$$

TWIST.

$$\frac{160 \times 100 \times 9\text{in.}}{27 \times 6{\cdot}00 \times \frac{11}{12}\text{in.}} = 965 \text{ Constant No. Twist.}$$

Names of Wheels.

$$\frac{\text{Crown wheel} \times \text{Bottom roller wheel} \times \text{Cylinder diameter.}}{\text{Cylinder pinion} \times \text{Bottom roller circumferance} \times \text{Wharve dia.}}$$

CHAPTER XV.

SPINNING FRAME ROLLERS.

Circumference of Fluted Rollers.

THE actual circumference of a fluted roller is different from that of a plain one, and there are various methods of ascertaining this difference.

The simplest method, for all ordinary purposes, is to multiply the extreme diameter, *i.e.*, from the top of one flute to the extremity of that opposite, by 3·33, to arrive at the actual circumference.

Other common but not correct methods are, first,—to get the mean diameter, *i.e.*, from the top of one flute to the bottom of that opposite, and to multiply this by 3·43 to find the circumference, this being of the proportion of "as 7 is to 24." Secondly, to take out in decimals the mean diameter, and to add to this the number of flutes in the boss, as so many extra points. The product when multiplied by the standard figures—3·1416, for finding the circumference of a plain roller—will give the circumference of the fluted roller.

The former of these methods gives too great a circumference, so that the yarn will thus receive more than the calculated twist, an error certainly on the safe side, but still an error.

Besides, it is not satisfactory to use the mean diameter of a fluted roller, as fluted rollers are gauged so many "flutes to the extreme diameter" in all cases. Therefore, it is advisable to make one measurement do for draft, for twist, and for checking the accuracy of the fluting of the roller, by seeing that the extreme diameter divided into the total flutes in roller gives exactly the stated "flutes per inch."

The second method of finding circumference of fluted rollers is not only incorrect, as also giving too great an actual circumference, but it is doubly so, in that a fine fluted roller—which has most flutes—has not so great an actual circumference as a coarse one, which has less flutes. Experiment will prove this to be the case. If a slip of paper be passed through a pair of revolving fluted rollers, it will, with the pressure, receive the exact indentations of the flutes. The number of flutes in the roller can then be counted off on the slip. We then have the actual circumference of the roller, on the strip of paper being stretched or pressed back to its normal condition. It will thus be found that for very fine flutes, say 40 per inch and upwards, about 3·25 is the required figure, which multiplied on the extreme diameter will give the actual circumference. Then for 32 to 40 flutes per inch about 3·3, for 26 to 32 flutes about 3·35, and for 20 to 26 flutes about 3·4. Average of all 3·33.

Size of Flute.

There is great diversity of opinion regarding the proper number of "flutes per inch," and the shape of the flute. Some maintain that as the point of contact is least where the flute is fine, the rove will be drawn more evenly and freer from small ticks or lumps where the flutes are fine. Others hold that coarse fluting is generally preferable, as it is most durable, and, on account of its powerful bite, produces a more level yarn with less likelihood of beading. The proper method is to proportion the flutes per inch to the weight of rove, as it is reasonable to suppose that the best yarn will be produced where all the fibres are held properly in check by the flutes.

That this object may be gained the flutes must be deep in proportion to the quantity of stuff to be retained in them, and as, like every thing else, a flute has its proper proportions, the deeper the coarser, and *vice versa*. Some, ignoring this fact, try and combine fineness of nip and sufficient biting power, by having fine but deep flutes ; but experience will prove that this is no gain, as when the flutes are so pronounced, it is not long before the tops are worn away so as to be the means of producing a rougher and more defective yarn than will be produced over flutes of the largest size, provided they be fairly proportioned. Others, to save the flute, fall into the opposite extreme, and have them too shallow. This causes an irregular drafting of the fibre, and if this evil be checked, by putting extra leverage on the pressing rollers, it is to their detriment, and to the increased wear and tear of the machinery, and power required to drive it, from so doing.

It may not be out of place here to remark that for those who have much work with fluted rollers, a sliding claw gauge, with a scale marked off in the principal sizes, as eighths, tenths, twelfths, fourteenths, etc., is very useful. Or calipers, with the toes so blunted or rounded out on the inside edge as to be put beyond the possibility of entering the flute, will combine expedition and accuracy in the finding of the extreme diameter.

If these rounded toes be flattened to not more than $\frac{3}{32}$ of an inch in thickness, they will take what may be considered the driving diameter of the wharve, which it is advisable to arrive at as nearly as possible, as taking the diameter the least thing too tight or too loose materially affects the twist calculation.

To return to fluted rollers, it may be gathered from the foregoing observations that it is advisable to have the top roller flutes coarser than the bottom roller flutes, and the flutes of the pressing rollers a little shallower than those of the boss rollers. It is impossible to define a properly-shaped flute, and in the opinion of the best judges there is no criterion but the eye.

The size or space occupied by different sizes of flutes on the surface of the roller is as follows :—

A roller fluted to	16	flutes per inch on diameter	= 0·1963 inch.
Ditto	20	ditto	= 0·1571 inch.
Ditto	24	ditto	= 0·1309 inch.
Ditto	28	ditto	= 0·1122 inch.
Ditto	30	ditto	= 0·1047 inch.
Ditto	32	ditto	= 0·0981 inch.
Ditto	36	ditto	= 0·0872 inch.
Ditto	40	ditto	= 0·0785 inch.
Ditto	44	ditto	= 0·0714 inch.

Refluting.

Table No. 1 will be useful in the checking of pressing rollers as they come from the fluting machine, to prove that the proper index wheel was used for that size of roller ; and that the cutter has been elevated to the proper position to give the required extreme diameter for that number of flutes. This is requisite, that there may not be that most glaring of faults in wet spinning—split flutes ; which ensure the dropping of the ends, nearly every revolution of the roller, giving the spinner much more than she can attend to, and making waste besides. Although for the medium and fine flutes, in Table No. 1, there are three and four flutes between each size, which insures the newly-fluted surface being clean and sound ; yet, by a patent arrangement it is possible to procure a fairly sound and accurate flute, when sized so closely as two flutes. This is effected by the hand wheel for raising and lowering the head, being notched to work in conjunction with the size of flute and the pitch of the thread of its spindle.

NO. 1.—FLUTED ROLLER GAUGE TABLE.

16 Dia.		Flutes.
1	lin. =	16
1 +	1-8	18
1	1-4	20
1	3-8	22
1	1-2	24
1	5-8	26
1	3-4	28
1	7-8	30
2		32
2	1-8	34
2	1-4	36
2	3-8	38
2	1-2	40
2	5-8	42
2	3-4	44
2	7-8	46
3		48
3	1-8	50
3	1-4	52
3	3-8	54
3	1-2	56
3	5-8	58
3	3-4	60
3	7-8	62
4		64

20 Dia.		Flutes.
1	lin. =	20
1 +	1-10	22
1	2-10	24
1	3-10	26
1	4-10	28
1	1-2	30
1	6-10	32
1	7-10	34
1	8-10	36
1	9-10	38
2		40
2	1-10	42
2	2-10	44
2	3-10	46
2	4-10	48
2	1-2	50
2	6-10	52
2	7-10	54
2	8-10	56
2	9-10	58
3		60
3	1-10	62
3	2-10	64
3	3-10	66
3	4-10	68
3	1-2	70
3	6-10	72
3	7-10	74
3	8-10	76
3	9-10	78
4		80

24 Dia.		Flutes.
1	lin. =	24
1 +	1-8	27
1	1-4	30
1	3-8	33
1	1-2	36
1	5-8	39
1	3-4	42
1	7-8	45
2		48
2	1-8	51
2	1-4	54
2	3-8	57
2	1-2	60
2	5-8	63
2	3-4	66
2	7-8	69
3		72
3	1-8	75
3	1-4	78
3	3-8	81
3	1-2	84
3	5-8	87
3	3-4	90
3	7-8	93
4		96

28 Dia.		Flutes.
1	lin. =	28
1 +	1-14	30
1	2-14	32
1	3-14	34
1	4-14	36
1	5-14	38
1	6-14	40
1	1-2	42
1	8-14	44
1	9-14	46
1	10-14	48
1	11-14	50
1	12-14	52
1	13-14	54
2		56
2	1-14	58
2	2-14	60
2	3-14	62
2	4-14	64
2	5-14	66
2	6-14	68
2	1-2	70
2	8-14	72
2	9-14	74
2	10-14	76
2	11-14	78
2	12-14	80
2	13-14	82
3		84
3	1-14	86
3	2-14	88
3	3-14	90
3	4-14	92
3	5-14	94
3	6-14	96
3	1-2	98
3	8-14	100
3	9-14	102
3	10-14	104
3	11-14	106
3	12-14	108
3	13-14	110
4		112

30 Dia.		Flutes.
1	lin. =	30
1 +	1-10	33
1	2-10	36
1	3-10	39
1	4-10	42
1	1-2	45
1	6-10	48
1	7-10	51
1	8-10	54
1	9-10	57
2		60
2	1-10	63
2	2-10	66
2	3-10	69
2	4-10	72
2	1-2	75
2	6-10	78
2	7-10	81
2	8-10	84
2	9-10	87
3		90
3	1-10	93
3	2-10	96
3	3-10	99
3	4-10	102
3	1-2	105
3	6-10	108
3	7-10	111
3	8-10	114
3	9-10	117
4		120

32 Dia.		Flutes.
1	lin. =	32
1 +	1-8	36
1	1-4	40
1	3-8	44
1	1-2	48
1	5-8	52
1	3-4	56
1	7-8	60
2		64
2	1-8	68
2	1-4	72
2	3-8	76
2	1-2	80
2	5-8	84
2	3-4	88
2	7-8	92
3		96
3	1-8	100
3	1-4	104
3	3-8	108
3	1-2	112
3	5-8	116
3	3-4	120
3	7-8	124
4		128

36 Dia.		Flutes.
1	lin. =	36
1 +	1-12	39
1	2-12	42
1	1-4	45
1	4-12	48
1	5-12	51
1	1-2	54
1	7-12	57
1	8-12	60
1	3-4	63
1	10-12	66
1	11-12	69
2		72
2	1-12	75
2	2-12	78
2	1-4	81
2	4-12	84
2	5-12	87
2	1-2	90
2	7-12	93
2	8-12	96
2	3-4	99
2	10-12	102
2	11-12	105
3		108
3	1-12	111
3	2-12	114
3	1-4	117
3	4-12	120
3	5-12	123
3	1-2	126
3	7-12	129
3	8-12	132
3	3-4	135
3	10-12	138
3	11-12	141
4		144

40 Dia.		Flutes.
1	lin. =	40
1 +	1-10	44
1	2-10	48
1	3-10	52
1	4-10	56
1	1-2	60
1	6-10	64
1	7-10	68
1	8-10	72
1	9-10	76
2		80
2	1-10	84
2	2-10	88
2	3-10	92
2	4-10	96
2	1-2	100
2	6-10	104
2	7-10	108
2	8-10	112
2	9-10	116
3		120
3	1-10	124
3	2-10	128
3	3-10	132
3	4-10	136
3	1-2	140
3	6-10	144
3	7-10	148
3	8-10	152
3	9-10	156
4		160

44 Dia.		Flutes.
1	lin. =	44
1 +	1-11	48
1	2-11	52
1	3-11	56
1	4-11	60
1	5-11	64
1	6-11	68
1	7-11	72
1	8-11	76
1	9-11	80
1	10-11	84
2		88
2	1-11	92
2	2-11	96
2	3-11	100
2	4-11	104
2	5-11	108
2	6-11	112
2	7-11	116
2	8-11	120
2	9-11	124
2	10-11	128
3		132
3	1-11	136
3	2-11	140
3	3-11	144
3	4-11	148
3	5-11	152
3	6-11	156
3	7-11	160
3	8-11	164
3	9-11	168
3	10-11	172
4		176

NO. II.—TABLE OF EXTREME DIAMETERS OF ALL SIZES OF FLUTED ROLLERS UP TO ONE INCH, SIZED TO ONE FLUTE.

Flutes.		16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48 =	Flutes per in. of one Inch.
1	on dia. =	1-16	1-18	1-20	1-22	1-24	1-26	1-28	1-30	1-32	1-34	1-36	1-38	1-40	1-42	1-44	1-46	1-48	
2	,,	1-8	1-9	1-10	1-11	1-12	1-13	1-14	1-15	1-16	1-17	1-18	1-19	1-20	1-21	1-22	1-23	1-24	
3	,,	3-16	1-6	3-20	3-22	1-8	3-26	3-28	1-10	3-32	3-34	1-12	3-38	3-40	1-14	3-44	3-46	1-16	,,
4	,,	1-4	2-9	1-5	2-11	1-6	2-13	1-7	2-15	1-8	2-17	1-9	2-19	1-10	2-21	1-11	2-23	1-12	,,
5	,,	5-16	5-18	1-4	5-22	5-24	5-26	5-28	1-6	5-32	5-34	5-36	5-38	1-8	5-42	5-44	5-46	5-48	,,
6	,,	3-8	1-3	3-10	3-11	1-4	3-13	3-14	1-5	3-16	3-17	1-6	3-19	3-20	1-7	3-22	3-23	1-8	,,
7	,,	7-16	7-18	7-20	7-22	7-24	7-26	1-4	7-30	7-32	7-34	7-36	7-38	7-40	1-6	7-44	7-46	9-48	,,
8	,,	1-2	4-9	2-5	4-11	1-3	4-13	2-7	4-15	1-4	4-17	2-9	4-19	1-5	4-21	2-11	4-23	1-6	,,
9	,,	9-16	1-2	9-20	9-22	9-24	9-26	9-28	3-10	9-32	9-34	1-4	9-38	9-40	3-14	9-44	9-46	3-16	,,
10	,,	5-8	5-9	1-2	5-11	5-12	5-13	5-14	1-3	5-16	5-17	5-18	5-19	1-4	5-21	5-11	5-23	5-24	,,
11	,,	11-16	11-18	11-20	1-2	11-24	11-26	11-28	11-30	11-32	11-34	11-36	11-38	11-40	11-42	1-4	11-46	11-48	,,
12	,,	3-4	2-3	3-5	6-11	1-2	6-13	3-7	2-5	3-8	6-17	1-3	6-19	3-10	6-21	3-11	6-23	1-4	,,
13	,,	13-16	13-18	13-20	13-22	13-24	1-2	13-28	13-30	13-32	13-34	13-36	13-38	13-40	13-42	13-44	13-46	13-48	,,
14	,,	7-8	7-9	7-10	7-11	7-12	7-13	1-2	7-15	7-16	7-17	7-18	7-19	7-20	1-3	7-22	7-23	7-24	,,
15	,,	15-16	5-6	3-4	15-22	5-8	15-26	15-28	1-2	15-32	15-34	5-12	15-38	3-8	5-14	15-44	15-46	5-16	,,
16	,,	1	8-9	4-5	8-11	2-3	8-13	4-7	8-15	1-2	8-17	4-9	8-19	2-5	8-21	4-11	8-23	1-3	,,
17	,,	..	17-18	17-20	17-22	17-24	17-26	17-28	17-30	17-32	1-2	17-36	17-38	17-40	17-42	17-44	17-46	17-48	,,
18	,,	..	1	9-10	9-11	3-4	9-13	9-14	3-5	9-16	9-17	1-2	9-19	9-20	3-7	9-22	9-23	3-8	,,
19	,,	..	..	19-20	19-22	19-24	19-26	19-28	19-30	19-32	19-34	19-36	1-2	19-40	19-42	19-44	19-46	19-48	,,
20	,,	..	..	1	10-11	5-6	10-13	5-7	2-3	5-8	10-17	5-9	10-19	1-2	10-21	5-11	10-23	5-24	,,
21	,,	..	..	..	21-22	7-8	21-26	21-28	7-10	21-32	21-34	7-12	21-38	21-40	1-2	21-44	21-46	7-16	,,
22	,,	..	..	..	1	11-12	11-13	11-14	11-15	11-16	11-17	11-18	11-19	11-20	11-21	1-2	11-23	11-24	,,
23	,,	..	..	..	..	23-24	23-26	23-28	23-30	23-32	23-34	23-36	23-38	23-40	23-42	23-44	1-2	23-48	,,
24	,,	..	..	..	..	1	12-13	6-7	12-15	3-4	12-17	2-3	12-19	3-5	4-7	6-11	12-23	1-2	,,
25	,,	..	..	..	..	..	25-26	25-28	5-6	25-32	25-34	25-36	25-38	5-8	25-42	25-44	25-46	25-48	,,
26	,,	..	..	..	..	..	1	13-14	13-15	13-16	13-17	13-18	13-19	13-20	13-21	13-22	13-23	13-24	,,
27	,,	..	..	..	..	..	..	27-28	9-10	27-32	27-34	3-4	27-38	27-40	9-14	27-44	27-46	9-16	,,
28	,,	..	..	..	..	..	..	1	14-15	7-8	14-17	7-9	14-19	7-10	2-3	7-11	14-23	7-12	,,
29	,,	..	..	..	..	..	..	..	29-30	29-32	29-34	29-36	29-38	29-40	29-42	29-44	29-46	29-48	,,
30	,,	..	..	..	..	..	..	..	1	15-16	15-17	5-6	15-19	3-4	15-21	15-22	15-23	5-8	,,
31	,,	..	..	..	..	..	..	..	..	31-32	31-34	31-36	31-38	31-40	31-42	31-44	31-46	31-48	,,
32	,,	..	..	..	..	..	..	..	..	1	16-17	8-9	16-19	4-5	16-21	8-11	16-23	2-3	,,
33	,,	..	..	..	..	..	..	..	..	..	33-34	11-12	33-38	33-40	11-14	33-44	33-46	11-16	,,
34	,,	..	..	..	..	..	..	..	..	..	1	17-18	17-19	17-20	17-21	17-22	17-23	17-24	,,
35	,,	..	..	..	..	..	..	..	..	..	..	35-36	35-38	7-8	35-42	35-44	35-46	35-48	,,
36	,,	..	..	..	..	..	..	..	..	..	..	1	18-19	9-10	6-7	9-11	18-23	3-4	,,
37	,,	..	..	..	..	..	..	..	..	..	..	..	37-38	37-40	37-42	37-44	37-46	37-48	,,
38	,,	..	..	..	..	..	..	..	..	..	..	..	1	19-20	19-21	19-22	19-23	19-24	,,
39	,,	..	..	..	..	..	..	..	..	..	..	..	..	39-40	13-14	39-44	39-46	13-16	,,
40	,,	..	..	..	..	..	..	..	..	..	..	..	..	1	20-21	10-11	20-23	5-6	,,
41	,,	..	..	..	..	..	..	..	..	..	..	..	..	..	41-42	41-44	41-46	41-48	,,
42	,,	..	..	..	..	..	..	..	..	..	..	..	..	..	1	21-22	21-23	21-24	,,
43	,,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	43-44	43-46	43-48	,,
44	,,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	22-23	11-12	,,
45	,,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	45-46	15-16	,,
46	,,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	23-24	,,
47	,,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	47-48	,,
48	,,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	,,

We have said that split flutes cause excessive dropping of the ends, yet they are not the only cause of this evil. The spin may be rendered excessively bad by the rove-shifter getting out of order. This rod, as before remarked, guides the rove into the top-rollers, and is kept slowly travelling backwards and forwards about half the distance of the breadth of the top roller face, by being connected by a pin and spring with a heart or cam fixed on a stud, and in gear with the top roller end. Sometimes this rod gets out of order, and ceases to travel, so that the pressing rollers soon become so much cut up or furrowed as not to draw properly. Or again, the guide may travel too far in one direction, and thus cause the ends to fall, as they outstep the beaten track. The renewal of the pressing rollers, is, in such a case, only a partial and expensive remedy; as they, after renewal, require time to become bedded, before they work properly, and are no sooner at this stage than they also begin rapidly to spoil. This inexcusable evil continues until the defect in the machinery be rectified.

Rove-Shifter.

These pressing rollers are two bosses of wood screwed tightly, by means of nuts, against the collars of the iron axle, or arbour. They are held in position against the outside surface of the bottom roller, by means of a "saddle" riding upon the spring wire; through which latter the requisite pressure is transmitted. The upper portion of the same saddle also contains the top pressing roller, which is of brass; and the pair of pressing rollers, and the saddle itself, are kept in position by the arms of the latter being confined in grooves of the proper angle or curve, cast in the sides of the spinning frame "stands," *i. e.*, roller supports.

Spinning Pressing Roller.

The Saddle.

Stands of Spinning Frame.

The "flutes per inch" of the pressing rollers should be exactly similar to those of the brass roller on which they work; otherwise, an uneven, ruffled and bad spinning yarn will be the consequence. If the flutes be not similar, the pressing roller soon becomes so frayed and chafed as to be unfit for work, and must then be replaced by another; thus causing loss of time in changing, and waste of wood consequent upon the renewal of the flutes diminishing their number by a couple or more, and, proportionately, the size of the boss.

Bad Rollers.

These, however, are not the greatest evils resulting from careless fluting: bad rollers are very generally the cause of "beaded yarn." The rove is improperly and unevenly drawn, so that, on receiving the twist the yarn becomes snarled or twisted up in such manner as to destroy its appearance with little white lumps; these latter—called beads—unsnarling and breaking when the least stress is put on them. Beaded yarn is totally unfit for anything but waste.

Beaded Yarn.

The most suitable wood for making bosses for the spinning-frame pressing rollers is well-seasoned boxwood, cut up into bosses of the required breadth of face, and bored to fit the boss of the arbour on which they are to work. The boring of the bosses is a point on which a good deal of discrimination ought to be exercised. If there is a knot or a shake in the boss, it is only lost time putting it into work, as it will not spin; therefore the boring should be conducted in such a way as to allow of the turning-up to cut away all defects. Of course, where the wood is free from splits or knots, the proper place to bore is the exact centre, as then the face of the roller will not have a soft and a hard side, as is the case where the boss is not centre wood.

Spinning Frame Pressing Rollers.

After the bosses are thus cut and bored, they should, if of boxwood, be steeped one day in cold water, then on the second day this water should be heated up to a temperature of about 120 degrees, by having a system of steam-piping through the steep tanks, and the bosses should be allowed to

simmer in the warm water for two days. This water should then be allowed to cool down, the bosses remaining in it for about six days more. This style of preparing boxwood bosses is of advantage, because by it the sappy and open nature of the wood is changed, becoming of a tough and oily nature; and thus it takes a cleaner, smoother flute, than if the wood were hard, open, and splinty, as boxwood of the present day too generally is, if not put through some such process. The process of boiling, also, to a great extent, prevents the bosses splitting with heat during the time of stoppage, when they are not kept constantly wet. Such is the effect produced by boiling, that there will be no necessity for watering spinning-frame rollers on Sunday, if the rooms, and the water in the troughs, have been properly cooled down on Saturday evening before they are watered for the last time; whereas, if the bosses have not been so prepared, it is a matter of necessity to water them on both days in order to prevent splitting.

Other woods suitable for spinning-frame pressing rollers—such as thorn, holly, crabtree, laurel, etc.—should be cut down when the sap is lowest in the wood—say, in November. The trunks should then be sunk in a running stream; if possible, with their ends headed up, against the current, so as to permit of all the sap being driven out. The texture of the wood becomes, by this means, close and sound; and three months of this sort of seasoning are fully equal to nine months of exposure to the weather, which is the most common, and sometimes the only available, method of seasoning timber.

A large saving may be effected by having wood of a suitable size to cut into spinning bosses, and by allocating different sizes of bosses to different classes of frames. The coarse frame requires a large roller, for divers reasons—as, for instance, in it there is a greater distance between the nip of roller and the thread-plate eye, and thus, with a large roller, the spinner has still sufficient room to piece her ends. Then the saddles of a coarse frame are adapted to take in large rollers, and there is also greater speed upon the rollers of a coarse frame; therefore, a greater circumference is required to neutralise the wear and tear upon the roller. Also, the larger the circumference of the roller, the longer will a lap be in gathering on it; this meeting the case of coarse frames, where a few revolutions of a roller making waste of so coarse a lea as that spun on it, would cause a lap that could not be got off a small roller at all, as it would become so hard and strong with the pressure and small circumference.

Spinning Frame Axles.

Then, there should be only two sizes of axle or arbour-boss in the spinning department of any establishment; the larger for the coarse rollers, and the smaller for medium and fine frames. When the coarse rollers be so reduced in size as to be too small for further use in their frames, it might be thought that the breadth of face of the bosses could be reduced in size and they thus made serviceable for the finer frames, only for the misfortune of their being too large in the hole for the arbour of smaller size. Now, this method of preventing what seems unnecessary waste of wood is quite admissible between the medium and fine frames—therefore are the arbours of these of the same thickness—but is not feasible between the coarse and medium frames—for this reason:—the nearer we get to the heart of a stick or log, the softer and more open does the texture of the wood become; this, when coupled with the fact that spinning pressing rollers are not only growing smaller in size with each refluting, but are also tending towards becoming half decayed or "dozed" from their being always permeated by moisture of varying temperatures, renders rollers that have become too small to work in the coarse frames unfit for any further service than to replenish the furnaces.

Size of Bosses.

Consequently it is very mistaken economy to purchase nothing but large sized boxwood, etc., for roller bosses,

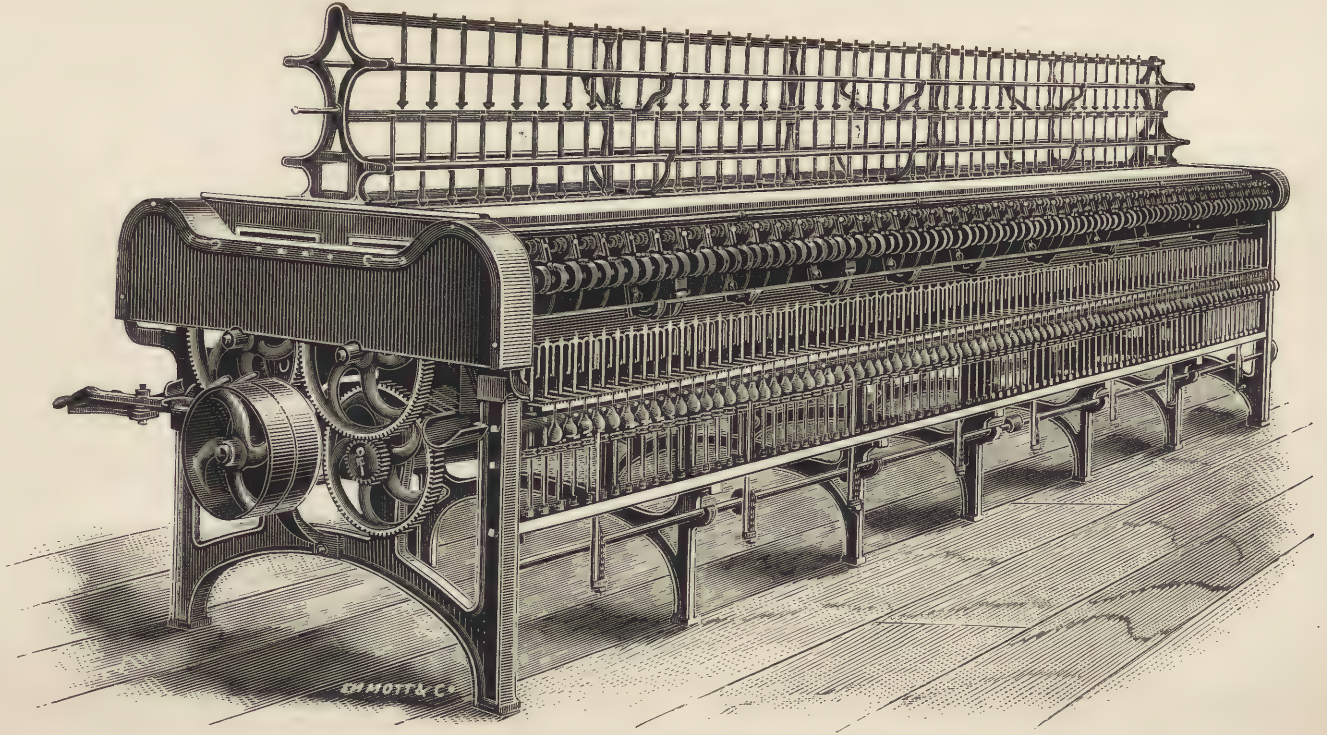
say $4\frac{1}{2}$in. dia.; thinking that by the time the coarse frames have taken their turn out of them, they—the bosses—will just be of suitable size and condition for the medium frames. But rather, procure close clean wood of an average of say 3in. dia., especially for the medium and fine spinning frames, exclusive of the larger stuff most suitable for the coarse frames.

Where there are thus only two diameters of arbour, that for frames of 32 flutes and coarser should be $\frac{5}{8}$in. diameter; and all frames of 36 flutes and finer should have arbour bosses of $\frac{1}{2}$in. diameter. Then all stuff above $2\frac{3}{4}$in. diameter should be bored to the $\frac{5}{8}$in. hole for the coarse frames, and all below 3in. diameter bored to $\frac{1}{2}$in. diameter for the fine frames. Let the largest bosses of the $\frac{5}{8}$in. bore be used for the coarsest frames, until they are wrought down to $3\frac{1}{2}$in. diameter, when they should be passed on to the next coarsest set of frames; and fluted down to the smallest workable size for that class of frame. Afterwards they are only fit for firewood. Let the largest of the $\frac{1}{2}$in. bore bosses be for the coarser class of fine frames—say, down to $2\frac{1}{4}$in. diameter—and then from $2\frac{1}{4}$in. down to the smallest size of workable boss for the finest frames. Although coarse frames, as a rule, do better with large pressing rollers, still there are exceptions, as in the case of wefts, either line or tow; when the smaller roller is found to do its work as well as, if not better than, a larger one, as there is a smaller number of flutes in contact, and not much speed. Therefore, as far as is practicable, the smallest rollers should be worked out on those frames which are on a poorer class of work, and, consequently, are likely to be driven slowest, so that laps will thus be longer forming on the rollers, and will not be so strong when they are formed, on account of the poor class of stuff.

It is impossible to lay down any rule as to how long a pressing roller should work, as so much depends upon the length of "reach;" the quality of fibre; the class of spinner; the condition of the frame—especially whether the rove shifter is working, and has been working properly,—the gauging of the rollers; and the class of wood—whether it be open or close, clean or shaky, and is bored to the natural centre, so that it may not have a soft and a hard side. There can be no specified time named for their continuing to work without impoverishing or beading the yarn.

Changing of Spinning-Rollers. Spinning-frame pressing rollers may work from one to twenty days, and the only accurate method of changing them is to allocate a certain number per day to each side—say, ten rollers—allowing the spinners to place the new rollers over those they know to be doing worst in their sides. The roller boys then come round, stop the frame, and put in the new rollers in place of the defective ones.

We cannot too strongly deprecate the most pernicious system of allowing one boy to do the changing of the rollers, without stopping the frame at all. The spinning frame should be stopped, and the rollers then changed by two boys, one for each side: the length of time the frame is idle is thus reduced to a minimum.



A NEW SPINNING FRAME.

CHAPTER XVI.

ON SPINNING.

We now come to a consideration of the "set" of the spinning frame, this being the relative position of the rollers to each other, and to the thread-plate and bobbin and flyer. When these relations are shown by a sketch they are all embodied in the term "Lines of a Spinning Frame."

The "Set" of the Rollers.

And first: There is much importance to be attached to the finding of the proper position to be taken by the pressing rollers upon the top and bottom brass rollers, as, if the former be not in contact with the latter at a certain point, there will be unnecessary bearing of the end either on one or the other roller face, and consequently more strain on the end. If anything, the spin will be best off the smoother brass flute, but a greater proportion of the laps will then pass round it, which is objectionable, as subjecting the brass roller to scoring with the picker, and, besides, it will wear more quickly off its true lines than if the pressure were less vertical.

As will be seen from examination of the lines of spinning frames, further on, the proper point of contact between the bottom rollers is where a line drawn at right angles to that between the nip and the thread-plate eye, and passing through the centre of both rollers, bisects their circumference. The position that the top rollers should bear to each other is found in a similar manner, with the exception that the line between the nip and the thread-plate eye must give place to one drawn from the nip, to a point the same distance outside the thread-plate eye, as is the amount of "bearing" on that eye. The point of contact of the top rollers must be on this straight line produced.

With the aid of a "humbug," most saddles can be set so that the pressing rollers will be properly balanced in the stands. With this, the tendency of the saddle will be upwards against the groove.

Saddle and Stand.

The proper angle that this groove in the stand above mentioned should have depends much upon the bevel of the outside faces of the top and bottom brass rollers. This is especially the case with the now generally adopted self-acting saddle.

The angle of this groove is arrived at by considering the shortest reach requisite, in conjunction with the largest pressing roller to be admitted. Having these, and with the aid of template rollers and saddle, in which latter the proper position of arm has been decided, the desired result is obtained: Mark off the centres of the various sizes of pressing rollers to be wrought in frame. Place the centre of the bottom saddle seat on each of these points consecutively, and at the same time keep the top pressing roller in contact with the top brass roller. The points on which the centre of the arm of saddle rest at the different positions, being connected, will form the centre line for the required groove in stand. The arm confined in a groove thus got will certainly keep the bottom pressing roller on the same point of contact, without regard to its size. It is apparent, however, that the same result cannot be arrived at in connection with the top pressing roller, since its position will always vary, as it will be drawn downwards when a larger pressing roller is put in, and will again be pushed up on a smaller one being inserted. Thus, this arrangement is really not self-acting, but only an im-

provement upon the older saddle, in which the point of contact of both pairs of rollers was alterable, and especially undesirable in the case of the bottom nip. On this latter style of saddle the bottom roller seat was attached to a stud working in a socket in the saddle, the socket being parallel to the line of groove in the stand. The putting in of a small pressing roller would tend to push up the top pressing roller until this tendency would be counteracted by the seat of the bottom pressing roller being screwed out from the saddle —by a special arrangement—thus again restoring the saddle to its proper balance on the spring-wire, and *vice versa*.

Force of Nip.

If the leverage be not fairly distributed over both top and bottom pressing rollers, the injury resulting to the spin might be serious, from the rove slipping in the top rollers, etc. If rove will pull back out of the top rollers without breaking short off, either the leverage is too little or badly distributed over the rollers, or the latter are so far worn as to be in urgent need of re-fluting.

Spinning Frame Gauge Table.

The following table places clearly before us the maxinum and minimum lea of yarn of different qualities, that may safely be spun on frames of any pitch and traverse, with the greatest range of reach that will be required for same. In fact it shows at a glance the capabilities of properly adapted spinning machinery.

SPINNING FRAME GAUGE TABLE.

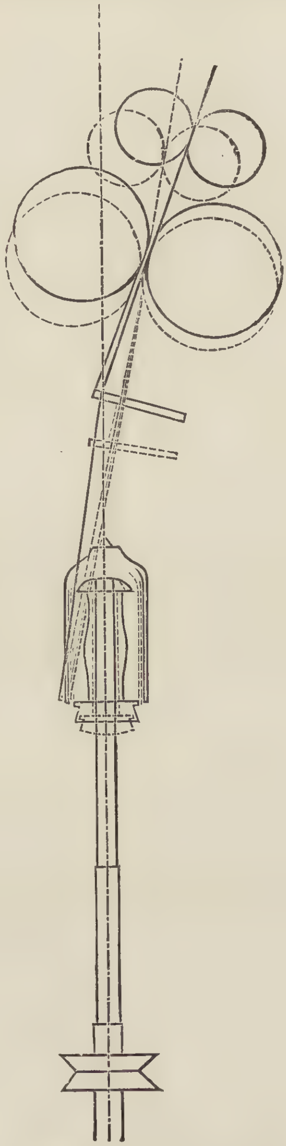
Pitch	3in.		$2\frac{3}{4}$in.		$2\frac{1}{2}$in.	
Traverse	3in. and $2\frac{3}{4}$in.		$2\frac{3}{4}$in. and $2\frac{1}{2}$n.		$2\frac{1}{2}$in. and $2\frac{1}{4}$in.	
Warp Lea ..	10's to 14's	14's to 18's	18's to 25's	25's to 35's	35's to 45's	45's to 55's
Weft Lea	8's to 10's	10's to 14's	14's to 18's	18's to 25's	25's to 35's	35's to 45's
Reach Range	5in. to $3\frac{3}{4}$in.	$4\frac{3}{4}$in. to $3\frac{1}{2}$in.	$4\frac{1}{4}$in. to $3\frac{1}{4}$in.	$3\frac{3}{4}$in. to $2\frac{3}{4}$in.	$3\frac{1}{2}$in. to $2\frac{1}{2}$in.	$3\frac{1}{4}$in. to $2\frac{1}{4}$in.
Pitch	$2\frac{1}{4}$in.		2in.		$1\frac{3}{4}$in.	
Traverse	$2\frac{1}{4}$in. and $2\frac{1}{8}$in.		2in. and $1\frac{3}{4}$in.		$1\frac{3}{4}$in. and $1\frac{1}{2}$in.	
Warp Lea ..	55's to 65's	65's to 75's	75's to 110's	110's to 200's	200's to 280's	280's to 350's
Weft Lea	45's to 50's	50's to 60's	60's to 90's	90's to 140's	140's to 210's	210's to 280's
Reach Range	3in. to $2\frac{1}{4}$in.	$2\frac{3}{4}$in. to 2in.	$2\frac{1}{2}$in. to $1\frac{7}{8}$in.	$2\frac{1}{4}$in. to $1\frac{3}{4}$in.	2in. to $1\frac{1}{2}$in.	$1\frac{3}{4}$in. to $1\frac{1}{4}$in.

This gauging, together with a well-proportioned flyer and bobbin head will give lines (see further on) that will allow of the minimum doffing of frame consistent with good spin, and the average closest set of rove guide to lip of trough—two very important items in a well-regulated spinning frame.

Spinning-frame "Lines."

To resume our observations on the lines of a spinning-frame we repeat what has previously been mentioned, that: It may be laid down as advisable to have the traverse of bobbin the same as the pitch of frame, where the spin is to be weft, and the traverse a quarter of an inch shorter than the pitch, where it is to be warp, as weft yarns get least twist, and therefore there will be a slower spindle than where the yarn has to be well twisted. This just suits, on account of the head of a weft bobbin being so small in diameter in comparison with that of a warp, to allow of less projection. The projection should be entirely regulated by the class of yarn to be spun—the better the yarn, the greater the projection, and the poorer the less. It is absolutely

necessary that, to prevent too much doffing, the barrel of the weft bobbin should be longer than that of the warp. This requires the spindle blade to



"Lines" of a Spinning Frame.

be slightly longer, or its proportions calculated from the shoulder instead of the tip, as before explained.

We now come to an explanation of the accompanying "lines," premising that the plain lines represent the set of a frame for spinning warps; whilst the dotted show the set of the same frame adapted for wefts. The broken line is the spindle produced. The spindle, as before shown, is proportioned off the pitch of the frame. Then the inside length and breadth of flyer must be depicted as on spindle top. Half the over-all length of the spindle, *i.e.*, the length of butt, is to be the distance between the flyer eye and a point on the spindle produced. At right angles to this point, and on the side of the spindle opposite to that on which the flyer-eye has been marked off, we find the projection, *i.e.*, the point on which the outside face of bottom brass roller is to abut. The amount of projection is dependent entirely on the width of flyer—narrow flyer little projection, and *vice versa*. Therefore have we narrow flyers for yarns of poor quality that have not strength to bear much strain at the threadplate-eye, caused by either greater projection above it, or the increased diameter of circle inscribed by the larger flyer below it. From this explanation it is evident that the putting on of narrower flyers and bobbins, when the change of spin is from warp to weft, only goes a small way towards fitting that frame for its work.

"Projection."

Thread-Plate "Bearing."

A line drawn from the point of projection to the flyer-eye, intersects the spindle produced at the point where must be the thread-plate eye, provided there were no stress or "bearing" placed on it. But, to steady the thread or "end"; to prevent excessive dragging; and to admit the use of a bobbin of as large size of head—to prevent too frequent doffing—as possible; it is necessary to have a certain amount of bearing on the thread-plate eye. This is procured to any desired extent by raising the eye above the intersecting point to any other point on the spindle produced. The bearing on the thread-plate eye will range from $\frac{3}{8}$ths of an inch to $\frac{1}{64}$, according to circumstances.

Clearing Bobbin Head.

When the thread-plate eye is elevated so as to give the necessary bearing, a straight line drawn from it to the flyer-eye must not do much more than touch the head of the bobbin when the builder is raised to its highest. This is to prevent any stress or friction between the end of yarn and bobbin head, during the spinning.

The Thread Plate.

The thread-plate must be at right angles to a line drawn from its eye to the nip of the bottom rollers.

Bevel of Rollers.

The position the top rollers are to occupy, towards the bottom rollers, is decided by a straight line being drawn from a point outside the thread-plate eye—equal in distance to the amount of bearing on that eye—through the nip of the bottom rollers, and thence produced. The outside edge of the top brass roller must project to this line.

The proper position that the top and bottom pressing rollers must occupy towards their respective brass rollers, has been before explained.

"Flies."

If the set of, and the bearing on, the thread-plate eye be not proportionate to the coarseness, *i.e.*, "lea," of the yarn, the throw or centrifugal force communicated to the latter by the velocity of the flyer and the rate at which the yarn is delivered, causes it not only to expand beyond the confines of the shoulder of flyer, but sometimes to fly out of the thread-plate eye altogether.

The yarn being thus uncontrollable is one of the greatest evils in spinning, as where it occurs the end usually breaks, and is very often twisted into the one beside it, and spun down with it. This causes a strand double the proper size, and twisted up to a great extent. If this is not wound off by the spinner, before she again pieces up the end, the thick thread will damage the appearance of the web. It might naturally be

supposed that the spinner will have sense enough to wind off these "flies," as they are called. But in many cases—in fact, it may be said in the majority of cases—she does not trouble herself to do so, as, besides the time lost in winding off, she would have the trouble of piecing up an extra end, which she generally avoids by pulling away the misplaced end, and piecing it up to its own bobbin.

These flies, besides pulling down ends and causing thick yarn, are very injurious in another way. When the end thus parts, the broken end, instead of passing down on to the bobbin, and remaining there, frequently flies off, catching round the circumference of the bobbin next to it. It is thus dragged off its own bobbin, and lapped over the yarn on the next bobbin, so that, when the latter comes to be reeled, the yarn will not reel off, and is returned to the spinning master as bad spinning. The evil is increased by the spinner, when unable to find her end, breaking any strand that comes to her picker point, and piecing on to it. This will, of course, prevent the thread reeling off, and may lead to the fining or dismissing of a spinner, who feels that she is innocent of the careless and reprehensible habit mentioned.

Slotting of Thread-Plate.

The cutting of the thread-plate slot, so that it may be perpendicular when the thread-plate is resting on its inclined brackets, instead of cutting it at right angles to the plate, as is often done; and the opening in of the slot into the eye as much to the right hand as possible, thus reducing to a minimum the chance of the end flying into the slot, and thus soon freeing itself, will be found decidedly advantageous; and will curtail the necessity of extreme dragging, thus insuring a better spin.

Flies will always be abundant where the pitch of frame is too fine for the range of lea spun over it, a fault very often seen in the spinning frame, and caused by a desire to save as much space as possible; and to get the few extra spindles thus gained, attended to without extra cost. But this parsimony overreaches itself, for it is generally impracticable to drive frames, where it is practised, up to the proper speed, and therefore no more yarn is got from them, but often a little more waste.

Lost "Ends."

Mention has been made of bad spinning being caused by ends not being picked up. It has been thought that driving the builder very quickly, and thus crossing the ends on the barrel of bobbin, would facilitate the finding of the end, by preventing its bedding among the others, and so being more easily turned up by the picker; but it is questionable whether the extra wear and tear thus put upon builder motion, spindle blades, and bobbins, and the increased difficulty of properly oiling the necks, from want of time, do not more than counterbalance any advantage gained by crossing the ends.

CHAPTER XVII.

SPINNING ROOM TECHNICALITIES.

Recently, an arrangement has been patented, which does away with the necessity of oiling the spindle necks more than once a week. This consists of a thin brass bushion (a part of the neck, and of the same bore as the neck itself), rising up in the dish of the neck. The bushion has a nick on the upper side, and it is encircled by a well-fitting, but not tight, brass washer, of similar appearance to the bushion itself.

Patent Spindle Neck.

There are two small nicks opposite to each other on the underside of the brass washer, of course resting on the dish, so that as long as there is any oil in the dish it passes into these nicks ; and, the washer being well fitted to the bushion, the oil is drawn up by capillary attraction between them, as they are in contact, and so oozes into the nick in the bushion itself, which is fitted to and encircles the spindle. The spindle, revolving at a very high speed, draws the oil from the nick as it is required, thus insuring a free but not superfluous circulation of oil. When the spindle is at rest there is no demand upon the supply of oil, consequently none runs to waste, as is the case in the common arrangement of neck, in which the oil lies in the dish around the spindle, and thus must of necessity run more or less to waste during the time of stoppage.

The greatest amount of oil is wasted by frequently-occurring short stoppages, *e.g.*, meal times, as just before these stoppages everything is, of course, hottest, from the continued friction of the parts, and the oil is then thinnest, and so escapes more readily than at any other time.

Necks especially are liable to be hot, both from the long bearing and the great velocity of spindles, and the friction of the band upon the wharve, which is affixed on the spindle butt immediately below the neck. The wharve should not, therefore, be put too close to the neck, but at the same time it must not be too far down on the spindle butt; as, if it be so placed, the passing of the knot over the wharve will more or less, perhaps imperceptibly, spring the butt. This will cause the neck to bear unevenly in its collar, so that not only will more force be required to keep the spindle up to its proper speed, but the spindle top will be more liable to vibrate. This has especially to be guarded against, a steady spindle being one of the first considerations in spinning.

Position of Wharve to Cylinder.

Bouncing of Spindle.

But, the wharve being properly placed on the spindle will avail little, unless it also stand in correct relation to the cylinder, off which it is driven. This is to prevent the "bouncing" of the spindle, or the tendency that spindles show to rise and fall in their steps, as much as the collar of the neck will permit.

To account for this bouncing, we must understand that the tendency of all bands, when they are tied tight round the spindle and are unobstructed, is to work to a point on the spindle horizontal with the centre line of the cylinder round which they pass. But the tendency to gravitate to a particular position implies that they work from some other position, and so it is; the bands on one side of the frame work downwards to this position, and on the other, upwards to it. The whole difficulty is solved by

noticing that, if the bands which work downwards are carried beyond the point towards which they gravitate, they will work up to that point again; and if the bands which work upwards are carried above the point towards which they tend, they will work back to it again.

When the underside of the band is driving, the tendency is upwards; when the upper side is driving, the tendency is downwards. Therefore, in the former case, place the wharve on the highest point, to keep the spindle down; in the latter, it will suffice to keep the wharve ever so little above the centre line of the cylinder.

Flyer Eyes. The eyes of the spinning-frame flyers are made of brass wire, soldered into the leg of the flyer, and then turned in a gauge. In the gauge, the flyer is placed on a boss made to fit it, and a spindle with a steel point is passed down through a socket bracketed right over the point at which the eye has to be turned.

Besides the steel point (which is the same diameter as the desired size of flyer eye) there is a small catch on the end of this spindle, which takes a hold of the wire, and on the spindle being turned in the socket by the hand, laps it round the steel point, thus forming the eye, on the surplus portion of the brass wire being cut off with pliers.

But before this surplus portion is nipped off, it should be utilised as a sort of handle to bend the eye to such a position that the end, instead of bearing upon the shoulder of flyer, and thus soon cutting a track in it which retards the spin, may bear principally upon the eye itself, which is easily renewable. The spin is benefited by regular renewal of the eyes, even though they be not much cut, as with dirt, doffing, and the abuse they get on "wiping-down" days, the eyes soon get loose and bent out of their proper position, if they do not altogether drop out.

Tinning Flyers. New flyers should always be steeped for some hours in a weak solution of vitriol and water. The object of this is to bring the portion of the leg, which is bored out for the reception of the brass wire, to the proper gist for retaining the "tinning." Without this preparation the eyes cannot be kept in the flyer, as the solder does not bind. It is advisable to re-tin all flyers, as they show need of it, or else the eyes will become loose within a fortnight; while, if the leg be well tinned, eyes may last from four to seven weeks, according to circumstances. We here note the cost of new flyers, and of repairing spindles.

Price of Flyers.

Flyer,	2in.	traverse	4s.	per dozen.	New spindle top ....4d.
,,	2¼in.	,,	4s. 6d.	,,	New spindle blade............6d.
,,	2½in.	,,	5s.	,,	New spindle foot............4d.
,,	2¾in.	,,	5s. 6d.	,,	Adjusting neck..............1d.
,,	3in.	,,	6s.	,,	Adjusting foot ....2d.

Spinning Room Oiling. The oiling of a spinning room is a very important matter, as power, wear and tear, bandcord, and turn-off, are all affected by it. The spindle necks should be oiled the first thing after each start, when they are cold and stiff, and most require it. A light, inexpensive oil is most suitable for the necks, as so much is used; say one-fourth pure sperm to three-fourths best mineral oil.

Origin of Black Threads. The roller journals and arbours should be oiled twice daily, with the purest oil put on sparingly and carefully, either with finger or brush; so as to prevent, as far as possible, the oil and dirt getting on the face of the rollers. If this happens, irreparable damage may be done to the yarn, by blading it and staining it with a substance that will very often not bleach out. This may render the cloth nearly unsaleable on account of the presence of black threads in it. It is advisable to use only sperm oil about the spinning frame rollers. No doubt it might be preferable if the lubricant had a little more "body" than

sperm has, to lessen the tendency to trickle over the roller bosses ; but it is scarcely safe to use lard oil, it is so much adulterated, and as for olive oil, it is believed to be more difficult to bleach out its stains from yarn or cloth, than any of the other oils.

Spindle steps, cylinder ends, guide and slack pulleys, and the studs of the gearing, should be oiled twice a week.

Quantity of Oil to Spinning Room.

About one quart of oil per frame per week will meet all demands in the spinning room.

Oilers' Duties.

The boys, whose duty it is to look after the oiling of the frames, should, after the stoppage of the engines every Saturday afternoon, fill the caps of the cylinder ends and guide pulleys with tallow ; as also the builder pinion shaft bearings and the builder pinion.

These oilers have also to take off and repair the belts that are showing any tendency to rip ; they have to cool down the room and to frequently water the rollers, so that on Monday morning they may not be found dried up and therefore split. Attention to these matters will keep each boy fully occupied for some three hours every Saturday evening, the number of frames he has to look after being from twenty to thirty.

The same boys must be in their respective spinning rooms at least half-an-hour before the start of the engine each morning to regulate the steam for the spinning troughs ; to—in winter—light up the room, and to carefully water the rollers before the start of the frame. If the latter be not attended to the ends will stick to, or lick up round, the rollers, and so immediately cast the whole room into a state of confusion and waste making.

Morning Starts.

Apropos of this a simple but telling item in successful mill management is to get the engine started and kept dead slow for the first ten or fifteen minutes every morning. On a Monday morning, or after extraordinary stoppages, the time may be extended to half-an-hour or more ; the reason for this being that the machinery is cold and stiff, which causes an excessive licking-up in the preparing and dropping of ends in the spinning room.

Coupled with this recommendation to drive slow at starts is the additional one of insisting on all spinning frames being started as quickly as they can be got on, let the spinner be at her sides or not. The frame thus has the full benefit of the dead slow drive to free the bobbins gradually from the spindle, drag band, and builder ; to have all portions of the surface of the rollers properly moistened ; and to spin through that rove which has lain for a lengthened time in the water, and has consequently become more or less weakened thereby. If it be not convenient to lock the mill entrance promptly after the start of the engine and so render certain the presence of the spinners from the start of their frames, an effectual method of insuring their punctuality is to instantly dismiss or fine those whose "ends" may be down from the frame being left too long unattended.

"Getting Ends Up."

In concerns where they cannot, or will not, resort to some such simple and effectual method of checking waste and disorder in the spinning room, at the morning start, the endeavour to negative the evil is made in the following way :—The doffing mistresses are compelled to have their frames so doffed before previous stoppage, that they may run for at least ten minutes after the next start without requiring to be doffed. In the interim the doffers are employed in getting up the "ends" on the frames composing their "half" or "share." Now, this is a most pernicious system, as besides imposing on the doffing mistress and her doffers work which they feel to be extraneous to their legitimate occupation, it tacitly permits of spinners coming in late, and is even an incentive to them to be careless as to the state in which they leave their "sides" the previous evening. The consequences of this system

are summed up in these words—careless overlooker and spinners; discontented doffers; poor turn-off; bad piecing; and plenty of waste.

Piecers. "Piecers," that is odd spinners who are kept among a certain number of spinning frames, piecing up ends wherever their services are most needed, are a decided detriment to the economical and satisfactory working of a spinning room. They are prone to shirk their duties unless closely watched; they often favour, or become the favourites of particular spinners, and they afford an excuse for spinners to be careless in the mode of piecing their ends, as the perpetrator cannot then be convicted. Thus are bad "piecings," that fruitful source of annoyance and worry to almost all who hold any position of responsibility in a flax and tow spinning mill, increased to an indefinite extent. They are caused by the ends being pieced before the laps of waste are altogether cleaned off the roller, the tail end of waste being spun down into the yarn, producing unsightly lengths, called fishes, in it.

Bad Piecings.

As it is not always easy to decide whether these "fishes" are due to bad piecings in the preparing or spinning departments, "confusion may become worse confounded" where they make their appearance at all.

Prevention of Bad Piecings. The manager should be careful to put such material into his mixes, and to keep the machinery in such order that the spinning room overlooker may be able to drive his frames so as to get a fair turn-off, with his spinners minding two sides of line lea and one side of tow lea, unassisted by either piecer or doffer. Then may matters be considered to be in fair working trim; then, and only then, may we look for freedom from fault-findings and contention, and for the resultant "peace and prosperity."

Provided that there be no defect in the rove, it is possible to entirely prevent bad piecings in the yarn—in this way:—Give the spinners and doffers instructions to piece no ends whatever, but, when they drop, to twist up the end off the roller between their fingers and the palm of their hand, and then dexterously to lay it over the rest of the yarn, on the barrel of the bobbin. On this yarn being reeled, the reeler snips off the uneven and insufficiently twisted end with her scissors, and joins it by a weaver's knot to the end on her reel. A properly made weaver's knot is not noticeable in the cloth, which cannot be said of even one of the least glaring bad piecings.

Method of Working a Spinning Room. To do away with all piecers in a spinning room, may appear injudicious, as there will always be odd hands stopping out from sickness and other causes, and it is found difficult to fill their places unless by piecers. There are two ways of supplying the vacant places, either by keeping up a plentiful and well-selected staff of doffers, the pick of whom will be able to mind a side or sides fairly well, or by allowing to each spinning room a number of odd hands in proportion to the number of frames. These odd hands can be employed in various ways.

The former alternative has the advantage of securing a quicker doffing of frames, thus giving better turn off; as the doffers being numerous, they will have less ends to doff. The fact of the work being light will also tend to gather a sufficient supply of steady doffers; whereas, other firms, who work upon the principle of taking as much as possible out of the doffers, will have the doffing more slowly done, and will assuredly have no difficulty in limiting the number of doffers. Sometimes the work is so incessant as utterly to dispirit both doffing mistress and doffers, and it has often happened that the proprietors have been forced, by the scarcity of doffers, to employ spinners to doff, at spinners' pay. It is only the worst class of spinners that can be got to doff, and this does not mend matters.

Where there is this scarcity of doffers, there is the latter alternative—the

employment of "odd hands." These should be the picked operatives of the room, women to whom no occupation in their own department will come amiss, and who, in consequence, should be in the receipt of the highest wages. This additional pay should be put on the "bonus for full time," to insure good attendance.

The number of these odd hands employed, should be one to every fifteen coarse frames, and one to every twenty fine frames. Their duties should be :—To work in any spinning room, in the establishment, that they may be most needed in. To be able, and willing, to take the place of any doffing mistress, spinner, doffer, yarn carrier or sweeper, in that room ; and, when not otherwise engaged, to clean all rollers, troughs, bobbins, and the gearing, in their own room. They should on no account be permitted to speak to any person, unless on business, nor to piece an end, unless when acting as spinner, doffer, etc.

Besides endeavouring to procure a steady class of operatives, the spinning room overlooker should insist upon the bands being well kept on, and also the flyers; and that the frames shall be kept supplied with their full complement of rollers. Even doffs, that is bobbins off a frame all filled to the same extent, are a sure criterion of attention to these minor, but all-important, details.

Matters of Detail.

Where a room is carelessly minded, there is a great quantity of good rove made into waste, in the following way :—No overlooker will permit the spinners to let the last row, or half row, of rove remain on the barrel of the rove bobbin, as most of them would be inclined to do ; as this is rather a glaring fault, and sure to be resented by the preparing room overlooker, if it escape the observation of a higher authority. So spinners are instructed to spin up their "bottoms." However, some of them, well aware of the ease they secure to themselves by keeping their work "well before their hand," when they see the last row on the rove bobbin in their creel, take time by the forelock, and commence to wind the rove off, on to the trough lid. They then place a full rove bobbin in the place of the one thus emptied, and, tieing the end of the new rove to any part of that which has been run on to the lid, draw the whole through the water in the trough, thus effectually converting it into "wet waste." This they break off from the strand of rove passing into the top rollers, and from that coming from the lip of the trough, and cast it to the floor. The two ends, on being adroitly lapped together as they pass through the top rollers, may spin down without the place of their union being perceptible in the yarn.

Preventible Waste.

All this wilful waste has been made by the spinner, simply to avoid the piecing of an end at, perchance, an inopportune moment ; whereas, at little or no extra labour she could have loosely knotted the end of the new rove to the end of that lying on the lid, and, by turning the full rove bobbin the reverse way, have wound on to it the loose rove. The latter would then be all spun into yarn, the only waste being when the end would drop at the breaking of the knot, and so require to be again pieced up.

Putting in Rove.

Besides catching the spinner in the act, a very effectual way of detecting this evil practice, is for the overlooker to now and then examine the buckets full of waste, as they are being carried away by the sweepers ; wet rove is easily distinguishable from wet waste. The manager would do well to occasionally inspect the loads of wet waste, as they are being carted from his establishment to the dealer's stores, for the same reason.

The Wet Waste.

In some concerns the spinner is not permitted to stop her frame on any account, not even if the bobbins are so full that they are bearing against the legs of the flyer, as it is the

Doffing of Spinning Frame.

special duty of the doffing mistress to stop and start the frames. Now, in our judgment, the spinner should have full authority to stop her frame on its becoming too full, as doffing mistresses are only too happy to allow the frames to fill as full as they will work, on the supposition that this saves doffing. In reality, no time is saved to the doffers by this, as they are much longer laying all the ends which have fallen before the frame was stopped, and this loss of time lessens the turn-off, and increases the waste and bad piecing.

A spinner should be permitted to stop her frame for doff, on the condition of her having all ends up before so doing, and that the bobbins are sufficiently full. The oversight exercised by the overlooker and doffing mistress, will be a sufficient guard against these conditions being infringed by the spinner, and if it should happen that doffs, not properly filled, escape the observation of these two functionaries, there is not the least fear of the reeler overlooking it, as if there is one thing more than another that the reeler resents, it is small doffs.

On the spinner stopping her frame in consequence of the bobbins being full, it becomes the duty of the overlooker to require of the doffing mistress a reason for the frame lying off, and so being a dead loss, and if he really be in earnest, there is not much likelihood of his having to ask the same question twice.

Spinning Creels.

We had cause to mention the "creels" of the spinning frame. This is a sort of cage or stand placed over the backs of the troughs, and running the whole length of the frame; delft steps are inserted into the bottom creel board, to the number of spindles in the frame, and to permit of the proper taking in of the rove bobbins; there must be two rows to each side, or four rows of steps in the creel board.

Above this board is erected the creel top, at a sufficient height to admit the longest size of rove bobbin with freedom. This top is perforated with holes vertical to the steps, so that a wooden spindle, called a "skewer," may be run through the bore of the rove bobbins; and, its ends being then inserted in a creel step and top, the bobbin is left free to revolve.

It is plain that there will be more room in the creels of coarse pitched frames, and less in those of fine, so that this is another reason for regulating the pitch of spinning frame according to the lea to be spun; as the finer lea means the finer rove, and consequently a smaller rove-bobbin, and *vice versa.*

It is so essential to give the rove free room to revolve in the creel, that many are in favour of not attempting to put all the rove bobbins on one creel board, but they construct two tiers of creels, one above the other, and have only two rows of rove-bobbins in each.

Unless where the frames are very fine, and consequently low, and the creels reduced to the minimum height required for the short barreled fine rove-bobbins, these double creels are very inconvenient for the spinner to change her rove in, from their height. From this cause, also, the light is greatly obstructed; this being an evil, as good light is a very great desideratum in a spinning room. Of course, where "double rove" is spun, double creels are an absolute necessity.

Light and Heat.

Reference to "light" leads us to observe that it and "heat" are two all-important factors in the proper arranging of a spinning room. All the finest frames should be placed in that part of the room which is best lighted; and, if possible, all the coarser frames should be placed near the inlet end of the steam piping, as the coarsest yarns, as a rule, require most steam.

Steaming Troughs.

Often, through the steam piping being of small diameter, or in some way defective, and the coarse frames far removed from its inlet; the steam is so

softened before it reaches these troughs, as to be quite inadequate to raise the temperature of the water to such a degree as to prevent the "beading" of the yarn. Irrespective of beading, the general levelness of the yarn may be impaired, by the requisite temperature of water not being available for the due maceration of the fibre.

Construction of "Saddle."

Mention is made of the saddle and stand being so constructed as to keep the pressing rollers on the same point of contact or "nip," no matter what size of pressing roller may be put into the saddle; but so long as the saddle is in one piece, as at present, this object cannot be fully accomplished, as will be seen from the following description.

The saddle is simply the top and bottom pressing roller seats connected together by a bar of brass, bisected at right angles by the saddle arms, which are confined in the groove of the stands; and thus the position of the saddle is regulated according to the angle of the groove, and the point in that groove in which the arm may rest. There is a large hole in the body of the saddle just below the arms, but at right-angles to them, through which the "spring-wire," or the iron rod that communicates the power of the lever, passes and centres the leverage on the body of the saddle, by a nut screwed over the top of this spring wire and down on a washer, or "humbug," as it is called, which fits into nicks cut on each side of the hole. It is not anticipating to say, that the top pressing roller seat works up and down a slide which is a portion of the body of saddle, so that the distance of the seats on the saddle may be regulated according to the length of reach.

The arms of the saddle may be placed anywhere, or done away with altogether, as in Gordon's patent, but when they are made use of much depends upon their being properly posited, as the following remarks will show. If large pressing rollers are to be used, the arms must be kept high and well set out on the body of the saddle, but they must not be placed higher than will permit of the top rollers being lowered to the lowest reach likely to be required. The reason for this is that the inside edge of the arms of the saddle must be distant from the centre of the bottom pressing roller seat, half the distance of the extreme diameter of the largest pressing roller that is to work in that saddle and stand, *i.e.*, a pressing roller about one inch in diameter larger than that of the brass roller, if the frame be coarse, and about half-an-inch larger if the frame be fine.

Construction of "Stand."

Of the "stand" there are two different styles, one, in which the groove is parallel to the line that passes the centres of the bottom boss and pressing rollers; and the other, in which the groove is at that angle which will keep the bottom pressing roller on the same point of contact with the bottom boss roller, no matter how variable its size may be. The importance of keeping at least the bottom "nip" of rollers unchangeable, has been before under consideration.

The first mentioned style of stand is the oldest. It has the great advantage of being capable of receiving an unusually large size of pressing roller, without materially altering the "reach," as is the case with the more modern style. It is not difficult to perceive, that putting in a large pressing roller, and keeping the point of contact between the two bottom rollers nearly in the same place, by means of this groove being parrallel to their centres, will, of necessity, draw down the top pressing roller, as the saddle is in one piece. To obviate this difficulty, the bottom pressing roller seat is fixed upon a stud and screw working through the lower extremity of body of saddle, and parallel to the spring wire. The screwing up of the seat into the body of saddle draws the lower extremity of saddle inwards, by means of the pressure upon it, thus raising the top pressing roller to its proper position; and when the pressing roller is smaller than the average, the throwing out of this bottom pressing roller seat drives the lower

extremity of saddle outwards, thus drawing down the top pressing roller to its proper position. But, on account of the time lost in the screwing the saddles up or down to the required balance, on the insertion of a larger or a smaller pressing roller, and also on account of its being more costly to make, this style of saddle and stand is fast becoming antiquated. We think, the so-called "self-acting saddle" must have derived its name from the fact of this setting being done away with; but, in reality, no spinning frame saddle will be, or can with justice be called, self-acting, until it be of such construction as that, no matter what variation there may be in the sizes of the bottom pressing rollers, the point of contact of both top and bottom rollers—*i.e.*, reach—will not be affected. In the case of this so-called self-acting saddle, not only is the reach subject to variation, but so is also the pressure. This saddle is so balanced that there will be a fair proportion of weight cast upon both top and bottom pressing rollers, but if the size of bottom pressing roller be materially altered, and the point of communication of power to saddle be unaltered, there will be an uneven distribution of the power, to the detriment of the spin; so that, when the pressing roller is very large, the point of communication should be raised by placing the humbug on the topmost nick, and when the pressing rollers are smallest the humbug should be placed on the lowest nick, to regulate the power according to the distance of the centre of bottom pressing roller from the point of communication of power. Three nicks, spaced from one-eighth to one-quarter of an inch apart, according to pitch of frame, will be sufficient for the proper distribution of power.

"Face" of Pressing Rollers.

The importance of having the stands of a spinning frame properly spaced and the arbours of the pressing rollers an exact fit for the stands, cannot be over-estimated, as thus it becomes possible to have the breadth of the pressing roller face almost exactly the same as that of the brass roller. If, from worn or ill-fitted stands and arbours, the pressing roller has to be made broader than the brass so as to cover it, the edge or side of the wooden boss which may not come in contact with the brass soon becomes coated with a pasty substance, composed of the oily element of the flax and the woody and metallic particles there lodged by the water and pressure combined. The piecing of ends, changing of rollers, and disturbance caused by the doffing and changing of the frame, cause the yarn to become contaminated with this dirt, which dries on the thread in the form of a hard black tick that it is impossible to remove.

There is one objection to having the breadth of face of brass and pressing rollers exactly the same. Under such circumstances, when the stands and arbours begin to wear, there would be a small portion of the brass roller uncovered, which would, in consequence, soon become a ridge or burr that would damage new pressing rollers when put in, and in undue time necessitate the refluting of the brass roller.

The face of the pressing roller should be a shade broader than that of the brass roller, and where the frames are old and out of order, they require to be a good deal broader. This is a great disadvantage, as the broader the face the more leverage is required, to have the same effect; and the increased leverage causes the speedier wearing down of the brasses, a loss of power, and also a loss of stuff. (Messrs. Lawson and Sons, Leeds, now make a saddle which obviates the necessity for the "face" of the pressing-roller being any broader than that of the brass-roller.)

For this reason there is a nicety in having the breadth of brass roller face properly proportioned to pitch of frame—not too broad, so as to give rise to the above defects, nor too narrow, so as to prevent the proper rove shifting, and consequently to cut up both roller faces before the proper time; besides causing a larger percentage of split pressing roller bosses, from their being so light.

Where the pressing rollers do not cover the brass ones properly, and where much is done in the spinning of prime and light-coloured yarns, it is well worth the trouble and expense to get up a very fine jet of water over each boss, by means of copper tubing, with fine-holed nozzles inserted at the proper pitch. There should be a good pressure upon the water supplying these nozzles, so as to prevent their filling up with sediment, and to cause the squirt to impinge with force on the face of the roller, thus driving off all scum, and scattering itself, so that there may not be too much water lodged about the nip of the rollers. This would only open up and swell the rove, taking away from the smooth glossy appearance of the yarn.

Clean Rollers.

Dirt in Yarn.

Let us here note other causes for, and means of avoiding, the soiling of the yarn as it is being spun. The rove has to be guided over rails of brass or copper tube, into and through the trough. Over the first of these "rails" the rove passes on coming off the bobbin, so that it may be guided down between the "creel-board" and the "trough-back." This opening, or slit, must be no longer than will let the rove through without rubbing, so that the heat may be kept in, and spinning bobbins, etc., be kept out of the trough ; and thus unnecessary heat escaping, and destruction of bobbins, will be prevented. The "creel-rail" should be raised one-third the distance of the traverse of rove bobbin above the bottom line of bobbin, so that when the rove is being wound off the lowest end of bobbin it may not be too much strained in being drawn over the rail.

The trough-rail should be placed in the back portion of trough, in such a position that the rove on being passed round it may come direct from the creel-rail without coming in contact with anything. Especial care should be taken that the trough-rail may be entirely clear of the steam pipe, and under it in the trough ; so that the rove may not be damaged by scorching, and may be exempted from the influence of the water in ebullition.

Another reason why the rove should go to the extreme bottom limit of trough is, that it will thus pass through most water, and, consequently proportionately cooler, will suffice. Keeping the troughs very full also benefits the spin, for the same reason, and keeps the rollers washed besides ; but spinners, generally, will not keep their troughs full unless compelled to do so, as when their troughs are full, more water passes down with the yarn, and is thrown off by the flyer, so as to wet them more. For this reason we think that the least mill proprietors can do is to supply spinners with oil-cloth rubbers, free of cost, on condition that the old one be given in exchange for the new one, and that spinners, when leaving, give up their rubbers before receiving their discharge. If the troughs are sitting level the spinners can the more easily keep them full of water without their overflowing.

From the foregoing remarks it will be evident that shallow troughs are a mistake ; and a further objection to them is that they bring the rove nearer to the dirt or sediment in the trough.

If the rove be really so fine as to be incapable of standing the strain caused by the drawing through a deep trough, the old and oft-tried plan of making the rails revolve, so as to aid the rove, can be adopted. This plan has hitherto generally proved a failure, on account of the liability of the rove to lap round the rail, but this must have been caused chiefly by having the rails revolving always at the same speed, and therefore sometimes faster and sometimes slower than the rove ; whereas, if both rails and the trough lip (also revolving) were in gear together, and with the top roller, and all revolving exactly at the same surface speed, there should be no reason why the rove would even be as likely to lap as at present.

Dirty troughs are the hot-beds for the production of beaded, dirty, and stained yarn, and consequently should be systematically cleaned, at least once every two months. The best time for drawing is before meal times, so that the meal hour may be utilised for filling the troughs and heating the water. They should also, if possible, be washed out before the start after any very long stoppage; as from the rove rotting in them, and the water stagnating, a scum rises on the water, on the steam being turned on, that would destroy any yarn with which it would spin down. Besides, it requires time, and makes waste, to get this half rotten rove through the trough at all.

Dirty Troughs.

During the time that the rove is being changed in the creels, or when the troughs are being washed out, is the only desirable opportunity for the spinner to clean her top rollers, rove guide, and lip of trough; as much injury may accrue to the yarn from cleaning these parts when the frame is spinning. During this cleaning the yarn is liable to become partially stained and dirtied, and a custom, only too common among spinners, serves greatly to increase the evil. We refer to the custom of wedging small oily patches between the top rollers and the stands, so that the rollers may be self-cleaned by friction, and by the oil upon the patch. Naturally enough, some of the oil and dirt spreads to the face of the rollers, and the author has little doubt but that it is during the time that this cleaning-up of the rollers is going on, that there is such a quantity of yarn stained in such a manner as frequently to cause serious damage to the cloth into which it may be woven.

Dirty Brass Rollers.

We have remarked upon the evil of having the pitch of a spinning frame disproportionately fine for the lea to be spun over it. Coarse numbers require a large diameter of roller and a fair breadth of face, to spin to advantage, and where these requirements are in conjunction with the fine pitched frame, it is palpable that, to allow of the roller seats being proportionate to the size of roller, the neck of the journal and the side of the boss must be in very close contact; so that it is nearly impossible to prevent the dirty oil from flowing off the journal on to the side of the boss—especially on to the wider top—roller, and thence on to its face, where its spreading capacity is only checked by its coming in contact with the rove itself. It is, indeed, a unique and well adapted establishment, in which this assertion cannot be ocularly verified by seeing frames, the bosses of which—those that are next the journals—are blackened with dirty oil on the edge, yet quite as clean as the others in the centre of the boss, where the rove keeps a clean track for itself. This is another, and a worse, evil than that of double threads or "flys," caused by the greedy and shortsighted policy of trying to cram as many spindles as possible into the least space. Keep the pitch proportionate to the class of frame, so that the neck of the journal may be at a proper distance from the side of the boss, and thus permit the usual oil groove being cut on each side of the journal. Then the oil may flow into the groove but must there accumulate and drop off, as, if the groove be correctly formed, the oil will not have any tendency to flow up the other side of the groove, and so on to the boss.

Careless Doffing.

Besides dirty pressing rollers, dirty troughs, and dirty brass rollers, there are other ways in which the yarn can be sullied, as for instance, if the doffers be allowed to doff the bobbins with soiled fingers; or if they carelessly let the yarn on the bobbins come in contact with the slimy thread-plates or thread-plate brackets, as they lift them off the spindle; or if they throw them into their dirty aprons or baskets; or let them roll over the dirty floor. Again, refluted rollers are often thrown into very dirty steeps, and are taken out coated with a layer of the decayed vegetable and even mineral matter (coal dust) with which

the bottom of the tank is covered. In any or all of these ways can dirty yarn be produced—an evil which the ever increasing tendency of the trade to look for "turn-off," as being of primary importance, fosters and encourages to an abnormal extent. So much so, that from the tenour of the evidence given in a recent important law case, wherein damages were sought for loss sustained by dirty yarn, it seems to be pretty generally taken as for granted by all parties, that the appearance of these "black threads" must be looked upon as an unavoidable circumstance. Two points especially seem to have been a stumbling-block to both judge and jury—the fact of only single and lengthy threads bleaching out black, and also of their showing up especially in the warp.

Black Threads.

With regard to the first—only single and lengthy threads turning out black, we think that the already mentioned practice of cleaning the rollers by inserting oily patches, of itself goes far to elucidate the difficulty. These patches may be left in contact with the rollers for a "doff" or more, which means any length of yarn from 100 to 800 yards, or over.

The second point, namely, that of the black threads being seen mainly in the warp, is, in our opinion, not so easily disposed of, and the suggestions we can offer in explanation are by no means conclusive. They are, first, that spinners of warp yarn have more time at their disposal than if they were spinning wefts, and so they devote more of it to keeping their "sides" trim. Second, the newest rollers, and most of them, are usually given to the frames spinning warps. Now, if roller-bosses have been steeped in tanks which are too near to the coal-yard, it is probable that they have absorbed that which is so injurious to the yarn, as the evidence goes to show that it is carbon which is found so difficult to bleach out. Much must also depend upon the quality and mixing of the oils used for lubricating purposes; for instance, animal oil has not so much of the staining property as vegetable oil. There is a peculiar acid given off certain classes or mixtures of oil, which on becoming impregnated with the metallic particles that are separated by abrasion, produces matter that stains, often indelibly, any fibrous material that may come in contact with it.

This evil is not of necessity peculiar to the spinning, it may originate in the preparing department, from some of the rollers—especially in the roving frame—becoming contaminated by the viscid matter flowing from dirty and carelessly oiled journals on to the rubbers, etc.; or by drops of the same falling from the "hangers" of the shafting on to the machinery. A like evil effect may also be produced by brushing the parts of the preparing machinery when it is working, with dirty oily brushes, etc.

But, in the law case referred to, weight was attached to the fact that the evil of stained threads was intermittent; giving unusual trouble for weeks or a month at a time, or in particular classes or qualities of yarn, and then, perhaps, suddenly ceasing altogether for an indefinite period. Now, as explanative of this intermittent tendency, we can offer only two reasonable solutions, viz.:—a change of one or more hands, whether overlooker or operative; and some alteration in the quality of "mix" of the oil. Indeed, after reading the evidence given by spinners of the greatest practical experience, in the case referred to, we are forced to the conclusion that the subject of "stained yarn" is worthy of the most careful consideration, as it is one on which there is evidently the utmost diversity of opinion.

The "Reach."

We now pass to a discussion of the "reach" of a spinning frame. The reach is the distance from the outside extremity of the top roller to the outside extremity of the bottom roller; the saddle and stand being designed to keep the "nip" of the brass and wooden bosses near to these outside extremities. Then, the reach of

a frame depends upon the diameter of the brass rollers, as the shortest reach obtainable cannot be less than the sum of the diameters of the top and bottom brass rollers divided by two.

There is a nicety in being able to spin on the most suitable reach. If the rollers want refluting; if the water is not sufficiently hot, or, which amounts to the same thing, if the trough be too shallow or its lip too far removed from the top rollers, a longer reach will be necessary than is the case when the rollers, troughs, and steam-piping are in good order and properly adapted. Reaches too short are productive of "beaded" yarn; reaches too long, of weak, fishy yarn.

Heat in Troughs.

As before remarked, beaded yarn is also produced by the water being too cold, but it is not therefore to be understood that all yarns spin best and to the greatest advantage with hot water. Poor weft yarns often spin best with the water at not higher than a temperature of 90° F. In no case should there be necessity for raising the temperature above 160° to 180° F., as the hotter the water is made, the greater is the amount of "nature" that is boiled out of the material. Spin with the coolest water that is consistent with a reach short enough to give the most level appearance to yarn that must not show the slightest tendency to "bead."

So detrimental to the quality of the material is hot water known to be, that many and oft-repeated efforts have been made to supersede it by other agents, in the maceration of the fibre, but as yet without much success. One idea has been to lap the rove any required number of times round a reel revolving in the water, so as to keep the rove longer submerged. This necessitates a rather troublesome and costly arrangement, and with it it is not easy to prevent the rows of rove from becoming entangled and broken. Others have tried the introduction of foreign matter, such as black soap, soda, barley, blue bark, etc., etc., into the cooler water, with more or less success. Elm bark, especially, besides having the property of softening the fibre, also gives it a full and silky appearance.

Table of Spinning Frame Reaches.

We have pleasure in placing before our readers a table of Spinning Frame Reaches, which we believe will be found of much service. From being ourselves guided by it for years, in the alteration of reaches, we can say that where the mixing of the fibre, the regulating of the length of the spinning draft, and the degree of twist to be put into the rove, have received due consideration, we consider the information to be derived from the table far more reliable than any "thumb testing" can possibly be. Indeed, in the case of most frames spinning on short reaches, and in that of all fine spinning frames (these the very ones that require the most critical judgment) we cannot fall back upon our sense of touch, as we cannot insert our finger between the pressing roller and the arm of the saddle. It is not beneficial to the yarn, nor is it in any way desirable to be under the necessity of altering the reaches a couple or more times before the yarn can be considered to look right; it is rather dead loss of time and wages. Again, it is infinitely worse to guess as to what reach is most suitable, then to get the frame altered to that, and at that to leave it; possibly to the irreparable injury of all the yarn coming off that frame. Worse still: there may be enough of a particular sort of rove to supply dozens of spinning frames. These frames may be all similar, and therefore so should the reaches be when they are on similar work. If this length of reach be not the correct one, what a mutiplication of error, mismanagement and irretrievable loss have we here! Hence the value of the following:—

SCALE OF SPINNING FRAME REACHES.

Warp Tows.	Line Weft.	Line Medm.	Line Warp.	Range of Lea.	Yards of Rove per ounce.	Pitch.	Gauging
in.	in.	in.	in.	Counts.		in.	Counts.
3⅜	4¼	4½	5	12 to 15	35 to 40		
3¼	4	4¼	4¾	16 ,, 20	40 ,, 45	3	25 to 12
3⅛	3¾	4	4½	20 ,, 25	45 ,, 50		3¼ ,, 5
3	3½	3¾	4¼	25 ,, 30	50 ,, 60		
2⅞	3¼	3½	4	28 ,, 35	55 ,, 70	2¾	40 ,, 20
2¾	3⅛	3¼	3¾	32 ,, 40	65 ,, 80		2¾ ,, 4¼
2⅝	2⅞	3	3½	35 ,, 45	75 ,, 90		
2½	2⅝	2¾	3¼	40 ,, 50	85 ,, 105	2½	70 ,, 32
2⅜	2½	2⅝	3	50 ,, 60	95 ,, 120		2¼ ,, 3¾
2¼	2⅜	2½	2⅞	60 ,, 70	105 ,, 135		
2⅛	2¼	2⅜	2¾	70 ,, 80	120 ,, 150	2¼	90 ,, 50
2	2⅛	2¼	2⅝	80 ,, 90	140 ,, 180		2 ,, 3
1⅞	2	2⅛	2½	90 ,, 110	160 ,, 210		
1¾	1⅞	2	2⅜	110 ,, 130	180 ,, 240	2	200 ,, 80
1⅝	1¾	1⅞	2⅛	130 ,, 160	200 ,, 270		1½ ,, 2½
1½	1⅝	1¾	1⅞	170 ,, 200	230 ,, 300		
..	1½	1⅝	1¾	210 ,, 260	300 ,, 380	1¾	330 ,, 170
..	..	1½	1⅝	270 ,, 330	380 ,, 480		1½ ,, 2

Turn off.

We have looked into the cause and traced the effect of many of the not unavoidable evils so common in the spinning department of a flax and tow spinning mill. We think we have the most crying evil, and that which fosters all the others, to yet consider. We refer to the now very general, but suicidal, practice of making "turn off" the all-absorbing question. Hard driving:—makes heavy work, consequently deteriorates the class of operatives and increases their number; makes much waste; puts much wear and tear upon the machiney; increases the quantity of mill furnishings, so giving a dearer bundle; increases to the maximum all the evils connected with a spinning mill; and last, but certainly not least, is productive of the most inferior article. Whilst slow driving:—makes light work, and therefore draws a fair class of hands; makes little waste; light wear and tear upon machinery; saves mill furnishings, so producing a cheaper bundle; and reduces to a minimum all those little evils above mentioned; and last, but certainly not least, produces a better article out of the same stuff. The following table is submitted to show the difference between

HARD V. SLOW DRIVING.

Supposition ....{ Mill of 28,000 spindles at £2................ / Gross wages £29,000 per 307 working days. } ..55's average lea.

	Per bdl.		Per bdl.
To 15 (maximum) cuts, per spindle = 644,700 bundles, or	10d.·80	To 13 (minimum) cuts, per spindle = 558,740 bundles, or	12d.·46
,, Machinery, 12 years' purchase = £4,666, or	1d.·74	,, Machinery, 20 years' purchase = £2,800, or	1d.·04
,, 2 per cent more waste—cost £85 per ton = £2,100, or	0d.·78		
,, 7 per cent more wages (surplus piecework) = £2,030, or	0d.·75		
	14d.·07		13d.·50

This is £1,531, or over 5 per cent. on gross wages, of nett loss by hard driving, per annum; anticipated profits on each surplus bundle fully negatived by the increased mill furnishings, by the inferiority of the material produced, and from the loss consequent upon the workers becoming unsteady from overwork.

NOTE.—The item ¾d. per bundle for surplus piecework, on the maximum turn off, includes nothing but the dressing, reeling, and bundling, that the extra quantity of material has to undergo at the hands of pieceworkers.

CHAPTER XVIII.

GENERAL REMARKS ON SPINNING.

Arithmetical "Changing."

Though it is an undeniable fact that a spinning room is never so well looked after as when the overlooker understands and examines into the minutest details of his room, details which it may have taken months, and even years, for him to become conversant with; yet it by no means follows that a spinning master, on starting in a strange room, must be entirely helpless until he becomes acquainted with the peculiarities and "constant numbers" of his new room, as there are general rules for guidance in every spinning room, rules which any man who is fairly conversant with his business, and who understands simple and compound proportion and square root, will have no difficulty in carrying into effect. For instance, an overlooker need not of necessity have the standing numbers of the room to make his changes, standing numbers being merely for the purpose of reducing the calculations into the shortest and most expeditious form. Drafts can be increased or shortened by simple proportion, and frames changed from one count of yarn to another by compound proportion for the draft, and by square root for the twist; the only objection to this system being, that as the yarn was, so will it be proportionately light or heavy to its lea, and twisted so much above or below the standard. Frames changed after this manner will frequently be found twisting very slack indeed, to increase turn-off, and on rather a short draft to counteract the effect of the slack twist, and to make a better spin.

In altering the draft of a frame to spin a coarser or a finer yarn out of the same stuff, all that is necessary to know is the yards per ounce of the rove in the creel, and then to state the question in this way:—if, say, a 46 draft pinion spin 45 lea out of rove, 100yds. to the ounce, how many teeth will it take to spin 50 lea out of the same stuff? The draft pinion being a driver, on the quantity of stuff delivered into the rollers, it will take a smaller pinion, as less stuff must be delivered in; therefore, put the term of the same denomination or quantity synonymous with the required answer, in the third place, and the smaller or least of the other two quantities in the second place. Then we have as 50 : 45 : : 46 = 41 teeth, odd, required in the draft pinion to spin the stuff to 50 lea.

Suppose, now, that the same frame has to be changed to 40 lea, to be spun out of stuff weighing 90 yards per ounce, then state the case by compound proportion, taking one subject, say the lea, first; thus, if 41 teeth draft 50 lea, how many will draft 40 lea? More; therefore, as 40 : 50 : : 41 to the required number. The other subject is the yards of rove, so that if 41 teeth spin the required lea out of rove 100 yards to one ounce, how many teeth will spin the same out of 90 yards per ounce? less, therefore,

$$\begin{array}{rrcl} \text{as } 40 : & 50 & : : & 41 \\ \text{as } 100 : & 90 & : : & \\ \hline 4000 : & 4500 & : : & 41 = 46 \end{array}$$

teeth, odd, required to draft the new stuff to 40 lea.

As regards the proportionate twist in either or both of these cases, the twist wheel working must be squared, by multiplying the number of teeth

in it by themselves, and then proceeding to state the question by simple proportion, the square root of the quotient will be the requisite number of teeth. Take the frame changed, and suppose that a 60 twist wheel gave the 50's lea the proper twist, how many teeth will give 40 lea the same proportion? More, as 40 lea requires fewer turns per inch than 50 lea, and the twist wheel is a driver to the bottom roller, consequently the larger the twist wheel the more inches of yarn are turned off to the same revolution of spindle, thus giving less turn per inch. Then by square root $60 \times 60 \times 50 \div 40 = 4500 \surd = 67$, odd, teeth in twist wheel to proportionately twist 40 lea.

Duties of Spinning Master.

The general duties of a spinning room overlooker consist chiefly in looking closely after his rollers, flyers, bands, bobbins and reaches, besides keeping the troughs and room up to the proper temperature.

On Fluting.

We have already remarked, at considerable length, upon the boring, steeping, bossing, and fluting of the pressing rollers, and need only add to what has been said, that where all these matters are entrusted to steady, careful men, paid a fair day's wages for a fair day's work, there will not be a never-ending outcry about the scarcity of rollers, as inevitably follows from employing boys on day work; or the flagrant loss of time, turn off, and wood, resulting from paying them by the hundred or gross. When paid in this way, the boys hurry over their work, without any regard being paid to the manner in which the rollers are fluted. Indeed, they soon come to understand that the more defective rollers they turn out, the more work and therefore the more wage do they make for themselves. If they be paid by the day they have not this temptation to resist.

The cutters should be kept sharp, their sockets being well oiled before being put on the spindle. They should then be screwed tight in the head, exactly perpendicular to the centres. The centres should be kept true and firm, so that on a roller being put in, there may not be a possibility of its becoming loose, and falling slightly, thus causing one of the greatest evils in fluting—a high flute. Care must also be taken to have the cutter at the exact elevation for the index wheel then in use.

These are a few of the principal ever-recurring little matters that require close attention on the part of the fluting master and boys. Piecework induces the boys to make work for themselves, on the rollers to be fluted becoming scarce; as they have no compunction in destroying rollers by bad bossing, incorrect gauging, blunt cutters, slack centres or slides, etc., unless there is some responsible person in authority to prevent such practices.

For these reasons it is better either to entrust the bossing and fluting to honest and industrious men, or to pay a man, well versed in all the minutiæ of the fluting machine, to become fluting master; and to take charge of the paring, bossing, and clearing up.

The fluting master should guard against having too many "strippers"—rollers fluted down to the smallest size—dropping out of use at the same time. This will cause so many full sized rollers to be in work at once, as, perhaps, to make it troublesome to get frames adapted to take them in, and also renders it difficult to supply those frames with medium and small sized rollers, which spin to most advantage with such rollers, on account of the peculiarity of the class of work that is being spun over them.

The fluting master will also be able to point out all the defects in the machines to the foreman mechanic, and thus enable them to be kept in first-rate condition. He can also daily sharpen all the cutters and set them in the head correctly, and look after and keep up the stock of "arbours," so that the fluters can do with the minimum changing of index wheels and, consequently, with the least alteration of head.

Where the fluting is conducted upon this principle, the spinning master should not have much difficulty in getting his full complement of suitable rollers, thus saving much trouble and annoyance.

Flyers. We have spoken of the flyers and the proper mode of preparing them for work, and it is scarcely necessary to add that, after they are thus got into work, the chief consideration is to get them well kept on. This is effected by the overlooker always having a dozen, or so, spare flyers of each sort, over and above the entire frame of each different size of flyer for changing. Eyes can be soldered into these spare flyers at any moment, and so leave the flyer boy no excuse for having any flyers off through the room. As already explained, regular trimming of the eye-holes, and careful soldering in of the eyes, will reduce to a minimum the number of odd flyers that daily come off; but no amount of care will prevent a few becoming useless, from the eyes being displaced by coming in contact with some opposing force, the next flyer, the drag band, the spinner's picker, or something of the kind.

It is to lessen the chance of the flyer being thus disabled that the flyer with an eye-hole in each leg has been brought into requisition, and also with the intention of making the flyer last longer; but in the writer's opinion these double-eyed flyers are not advantageous, for many reasons. For instance, few spinners will take time to ascertain which eye is best set and least cut before they pass the end through it; and thus, from the fact of there being still two eyes in the flyer, it is taken for granted that there is no necessity for renewing them when they may both be unfit for work, to the serious detriment of the spin. Again, one eye may be dragged or fall out, and unless the flyer be then taken off and another or both eyes put in, the flyer will be off the balance, which is not desirable.

Or again, one eye of these double-eyed flyers being discovered to be defective, the flyer is taken off to have the eye renewed. The boy or man who solders the flyers, either from want of time or inclination, does not examine the eyes to see which is defective, but dips both legs in the molten solder, thus melting out both eyes. This is a serious loss of both time and stuff. Double-eyed flyers have other disadvantages, for instance, on wiping-down day in the spinning room, when the frame of flyers is being washed in a mixture of warm water and waste oil to cleanse them, there will be just double the usual number of eyes bent and pulled out from their becoming entangled. Then these flyers require to be washed more frequently than those which have but one eye, as the spinner cannot keep even the one leg clean by scraping the dirt off with her picker, as she can do when there is no eye at the end of the leg. Flyers are generally found to wear quickest at their "boss," especially when the spindle-top is much worn, or not exactly the same pitch as the thread of the boss, and when the doffing of the frame is excessive; therefore there is nothing gained by having the second eye in them.

The chief points to be attended to in connection with the flyer are:—Have the brass wire a proper fit for the socket; have the leg of the flyer sufficiently long to admit of a "close up" and therefore strong eye being turned. Before clipping off the superfluous wire give the eye a "set" which shall prevent the yarn from bearing on and cutting the shoulder and leg of the flyer.

Some spinning masters go to the trouble of examining each frame of flyers as they are replaced by new ones. They retain those flyers whose eyes are not cut and use them as spare flyers, making up the complement or "frame of flyers" by replacing these with the same number of rejected flyers. This for the reason that the person who solders the flyers should be instructed not to receive from the spinning rooms anything less than the full frame, and therefore should be required to

send back nothing but the complete set. Otherwise there will be no accounting for missing flyers.

Bands.

It is also very necessary the spindle bands be all kept on. If any bands or flyers be permitted to be off for any length of time, not only does this militate against the turn-off but the bosses of the pressing rollers thus rendered idle are much damaged from their becoming dry and coated with compressed oil and dirt. On such a boss being again put to spin yarn it stains the thread, and is likely to bead it as well.

There are many little points which, if the band-tier attends to, will cause his bands to be far more easily kept on, and thus permit of his using less bandcord than his allowance. For instance, sprinkling oil on the bandcord as it is being rolled into a handy ball for immediate use is found to be very beneficial in keeping out the damp and wet which contracts the bandcord, and afterwards results in the increased expansion or stretching that is so trying to the bands. Then, again, keeping the knife for cutting the bandcord sharp, so that the ends being cut-clean will retain the twist better, and even making this point doubly sure by passing in a little twist with the fingers before tying the knot, will tend to make the band run longer. The boy should throw his whole weight against the band before tying the knot (which must, of course, be the interlapping loop, which has the property of getting tighter the more it is stretched) to stretch the band to its utmost limit. On the knot being tied he should be careful neither to cut the ends too long, so that those of one band will strike those of the other, nor too short, so as perchance to slip.

Bandcord Allowance.

It is impossible to state definitely what should be a proper allowance of bandcord, so much depends upon the speed of the spindle, and its proportion, the manner in which the oiling is done, the shape and size of wharve and cylinder, the temperature of the room, and the condition of the troughs,—whether leaky or not;—and lastly, the quality and weight of the bandcord itself. However, a general average weight of bandcord, per frame per week, may be estimated at ¾lb. in coarse room, ½lb. in medium room, and ¼lb. in fine room, or say,—

1¾in.	2in.	2¼in.	2½in.	2¾in.	3in.	Pitch of frame.
3×2	3×3	3×4	3×5	3×6	3×7	Ply of bandcord.
·2lb.	·2lb.	·3lb.	·5lb.	·7lb.	·9lb.	Per frame per week.

Having made a fair allowance for each room, the band-tier should be allowed a bonus of half the marketable value, on all bandcord saved; as this saving mainly depends upon the increased exertion and care which he exerts in the tying. Of course the overlooker must see that he does not attempt to save bandcord by leaving spindles idle. This point being secured, it is all gain to the employer to encourage this saving, as he buys in the bandcord for about half-price, while, at the same time, the proportion of slack bands—which cause uneven twist—is reduced, from the bands being more carefully tied on. More careful oiling of the "necks," where the band-tier does the oiling, is also ensured.

It may be mentioned, to show how much depends on the boy, that we have seen one band-tier dismissed for being unable to do without four pounds weight in addition to the weekly allowance, whilst his successor, started on the same allowance, had twenty-two pounds saved in his first three months, and had besides kept on the bands better during this time. The former boy had never been accustomed to work for a bonus, the latter had. It is customary to allow the band-tier from two to three pounds weight of bandcord for tying a cylinder after it has been mended, or on the

frame being newly started, or after repairs. It is very hard work to tie a frame of spindles, and consumes nearly two pounds of bandcord.

We now come to matters which are entirely outside the province of the ordinary spinning room overlooker, such as, for instance, the bobbin.

Bobbins.

As before mentioned, spinning bobbins can be manufactured out of almost any sort of wood, as alder, poplar, sycamore, boxwood, white birch, ash, greenheart, teak, mahogany, etc., etc. Odd bits or branch wood of most of these sorts will do sufficiently well, provided that it be thoroughly seasoned and free from knots. Bobbins are now being made of even compositions of india-rubber, pulverised paper, etc.

The softer kinds of wood are best for the larger, and consequently stronger, built bobbins. To give satisfactory wear soft wood bobbins should be "bushed" with boxwood bushions for about half-an-inch at each end, leaving the rest of the barrel chambered. The bobbin can thus be made a better fit for the blade of the spindle, without danger of its sticking to it through becoming warped by the heat or swollen with the damp.

For the medium and fine sizes of bobbin some hard wood, as mahogany or boxwood, is best. Boxwood bobbins are certainly the most durable, they thus require a lighter barrel in proportion to their size, this lessening the amount of doffing; but they labour under the disadvantage of being very heavy and of being liable to cast or warp. It may not be out of place here to remark that warped boxwood bobbins can be brought back to their proper shape by being spread upon a level floor and then covered with their own shavings and sawdust, which must be kept damp for a few hours.

Mahogany is both durable and light, and is not given to warp, therefore it is likely to prove the most serviceable, even the cheapest in the long run for all but the largest size of bobbin. Where it is customary to dry the yarn on the bobbin in thin cages put into a drying press heated by steam to a temperature as high as 140° F., it is absolutely necessary to use mahogany or teak, as they are the only woods that will at all stand the extremes to which this mode of yarn drying subjects the bobbins, and even bobbins of this wood, if not of extra stout build, will shrivel up and warp to such an extent as soon to be useless.

It is to save the expense of reeling that some warp yarns are dried in this manner, as the dry yarn is wound direct from the bobbin on to spools, off which it is warped on to "beams." Many persons who have tried this method of drying yarn have been deterred from following it up

Bobbin Stains.

successfully, by finding the row of yarn next the barrel of the newer mahogany bobbins stained by the sap drawn out by the action of the wet yarn and the great heat. This stain is found nearly impossible to bleach out, and for a long time there seemed no means of preventing it. It may, however, be almost entirely obviated by steeping the bobbins for some hours after they have been "chambered out," in a mixture of about five-sixths of raw oil and one-sixth of turpentine. They should then be thoroughly strained for an hour or two by being drawn up out of the cauldron of oil in a large strainer made to fit inside it and into which the bobbins had been put. On being thus strained they must be tied up in an ordinary coarse bag or sack, and placed over the boilers to dry. The oil that does not soak into the bobbin will flow to the under side of it, and can then effectually be got rid of by turning the bag upside down, when these deposits of oil will dry back into the bobbin.

Bobbin Storing.

The bobbins having been thoroughly cleansed from oil, they should be brought to the bobbin store and emptied into large boxes or bins, and if here allowed to lie for some

months before use they will be so thoroughly seasoned that there will be no trouble from their shrinking or from sap and oil stains.

Mahogany Bobbins.

If mahogany be dark in the colour it is one of the signs of its being good, as compared with baywood or Spanish mahogany and Sabicue, which are light in tint and in specific gravity, and are porous. Therefore when the best mahogany bobbins are ordered, the bobbin manufacturer should be instructed to deliver them in the state in which they come out of the lathe, not in any way steeped or oiled; as by steeping a poor class of mahogany in a solution of lime and water it may be made to assume the appearance of good sound wood. But the lime-water is very injurious to the mahogany.

We need not try to describe a correctly shaped spinning bobbin, as the shape must depend upon circumstances, but a few leading remarks may be made on the subject.

Bobbin for Wefts.

A bobbin for weft yarns should be as light as is consistent with durability, and constructed so as to bear as little as possible on the builder. A weft bobbin should never be constructed of boxwood; its base should be rounded out, convex, so that only the bushion will bear upon the builder-boss, which latter must be a pretty close fit to the spindle blade in consequence. The advantage of this is, that the bobbin cannot stick to the builder in the same manner as if its base were either flat or concave. If concave, it sticks to a certainty, because of the accumulated water and oil that assist in producing more or less of a vacuum between the bobbin and builder. This tendency to stick does not matter much when the yarn is good warp, and where it is understood that a good broad base helps to steady the fast revolving and heavily loaded bobbin; but in the case of wefts it is simply ruinous, as it involves the dropping of nearly all the "ends" when the machinery is started, cold and stiff after a long stoppage.

Bobbin Butt.

The base of a bobbin should always be a little broader than the head, and the yarn should be built a little fuller to the bottom of the barrel in consequence. This makes the bobbin less top-heavy, whilst it holds more yarn to the same projection of roller The base should also be pretty deep, to lessen its tendency to split from the heat raised by the friction between it and the drag-band; and also to allow of a fair thickness of stuff being above the level of the drag-band. This has the triple advantage of the bobbin not being so likely to chip off at this part as if it were thin; of preventing any yarn that may be built too low by a displaced flyer-eye, from coming in contact with the drag-band, and so being frayed and cut; and of effectually clearing the drag-band from the flyer-eye when the builder is at its height. The drag-band groove should be most incised at the level of the band, and from that slanted off to nothing at the base: this to prevent the bouncing of the bobbin upon the spindle, as the pressure of the band thus acts downwards as well as inwards.

Bobbin Barrel.

The barrel of the bobbin should be kept thickest towards its middle, where it has not the benefit of the bushion to strengthen it. In the middle of the barrel all bobbins are weakest, especially when they have been "chambered out" with a lathe bit made for the purpose, to make them lighter and to allow of their being a nicer fit for the spindle. The swelling out of the barrel towards the middle is called "cocking" it.

Bobbin Head.

The head should be made as small as is consistent with a fair holding capacity and freedom from a tendency to let the yarn off, and it should be well rounded off on the shoulder, to prevent the end from bearing on it when the builder is up.

There should be a bobbin store in every well-regulated concern, this to allow the holding of large stocks of bobbins, and, consequently to insure their being thoroughly seasoned before being put into work. Where the store is thoroughly dry and airy, and the boxes in which the bobbins are kept are well raised off the floor, and perforated in both bottom and sides, and with no top or lid, the longer bobbins are kept the more they improve, and the more durable they become. Where large stocks are kept there should be three compartments —one for those coming, one for those which have come, and one for those in use; and the more turning they get from one to another of these compartments the better, so long as they are not mixed. It is before the bobbins are going into use that those which have been chambered, and those which are bushed, should be "rimmered" out.

Bobbin Store.

This rimmering out is simply the passing of the bobbin over an awl revolving at high speed in the wood turner's lathe, the awl clearing out the bore of bobbin to the exact size of the spindle blade over which it is to work. The reason why this should not be done before the bobbin is going into work is that in seasoning, the bobbins dry in, so that if let lie long after being rimmered out and made a proper fit, there will be a likelihood of some of them not fitting the spindles. This should, as far as possible, be guarded against, as very often a bobbin does not commence to stick until there are many rows of yarn on it; it must then be taken off and put aside until there is a sufficient number gathered to be sent down to be rimmered out. This tends to mix and dirty the yarn. Sometimes it results in loss of both yarn and bobbin, as mischieviously-inclined spinners or doffers often destroy their tight bobbins by bursting them open on the "spring wire" of the frames, to save any further trouble with them. Bobbins are often destroyed in the same way, simply from the careless putting on of the bobbin over the spindle top, having knocked out a bushion. Each doffing mistress should have a box for all such damaged bobbins, and another one in which to keep the same quantity of good bobbins given to her in exchange by the spinning master, who should have under his control a large box, with compartments to the number of the different sizes of bobbin in his room, and a supply of any bobbins he might require to meet emergencies. If this system be carried out there need not be a bobbin wilfully destroyed or lost in the room that cannot be traced to the culprit, who should be made to pay dearly for his or her negligence. In some concerns, where they cannot or will not either keep a bobbin stock, or introduce a system such as that described into the spinning room, the difficulty is met by making the bobbins a very loose fit for the spindle, thus making allowance for the swelling and warping of the unseasoned wood; but the remedy is worse than the disease, as the bobbins will neither wear nearly so long, nor spin nearly so well, besides wearing the spindle blades off the round quickly by their loose fit.

Rimmering Out.

In large concerns it would be very desirable to introduce driving power into the bobbin store, so as to allow of the fitting up in it of a lathe, and a revolving wood, iron, or tin square box. There could then be a responsible steady man to take charge of this bobbin store, his duty being to count, turn over, keep stock of, chamber and rimmer all the bobbins, and receive the broken bobbins in exchange for new ones. The revolving square box would be for the purpose of oiling all softwood bobbins so as to keep out the wet. The manner of oiling them is to half fill the box with bobbins and to put in a patch or two of coarse flannel saturated in linseed oil. The box being closed up, is made to revolve slowly by means of a belt from the driving shaft. The bobbins are thus thrown in contact with the oily patches, with

Bobbin Stock.

each other, and with the side of the box. The oil is thus thoroughly spread over their surfaces, and with the friction received they are more or less burnished, and thus rendered impervious to the damp.

The comparative average cost of different kinds of spinning bobbins is as follows :—

	Mahogany.	Boxwood.	Soft Wood.	
	s. d.	s. d.	s. d.	
$1\frac{1}{2}$in. traverse by $\frac{3}{4}$in. butt at	5 0	3 9	3 3	Per Gross.
$1\frac{3}{4}$,, ,, $\frac{7}{8}$,, ,,	6 3	4 2	3 6	
2 ,, ,, $1\frac{1}{8}$,, ,,	8 0	4 6	3 9	
$2\frac{1}{4}$,, ,, $1\frac{3}{8}$,, ,,	9 0	5 0	4 6	
$2\frac{1}{2}$,, ,, $1\frac{1}{2}$,, ,,	10 3	5 9	5 0	
$2\frac{3}{4}$,, ,, $1\frac{5}{8}$,, ,,	12 0	7 0	5 9	

A stock of ten bobbins per spindle will not be found either too costly or too bulky to have always on hand. With certainty we can say that where the stock is the largest the consumption will be least, and *vice versâ*, so that the increased interest, insurance, etc., will be repaid a hundredfold in the much greater durability of the bobbins.

For the reasons already mentioned it is impossible to more than approximate to the length of time a spinning bobbin will wear. Badly seasoned and selected soft wood bobbins may not last more than three months on an average, where sound bobbins of closer grained material may be in work as long as three years.

Guide Pulleys.

As spinning frames are generally sitting at right angles to the driving shaft, they have to be driven over "guide pulleys." These pend from beams or columns, at the ceiling, and so raise the belts entirely above the heads of the operatives. They also facilitate the driving from both sides of the shaft, thus steadying it, and give more power to the belt, as it laps more round the surface of the drum and pulley ; at the same time belts running over guides do not shift on the drum when the belt is passed from the tight pulley to the slack one, consequently the face of the drum need not be broader than the extreme breadth of the belt, thus giving a tidier appearance to the shafting.

The guide pulleys are contained in a pair of sheaves or wings attached to each side of a hanger, so as to be movable in any direction, and it is by setting these wings properly that the belt is made to run straight on the guides. If it be remembered that the natural tendency of a belt is to run towards the highest point, the advisability of keeping the faces of both drums and pulleys very slightly convex, or raised towards the centre, will be apparent, and the setting of the guide pulleys made easier ; for the same reason, in setting them, the pulley over which the driving, or tight side of the belt runs, must be moved up or down, according to whether the belt tends to the outside or inside edge ; and the pulley over which the driven or slack side of the belt runs must be moved horizontally, in or out, according to whether the belt is inclined to the inside or outside edge.

Repairs to Spinning Frame.

A very important consideration in the successful working of a spinning mill is the keeping of the spinning frames in good condition. If this be neglected, the consequence may be most serious, a poorer class of yarn, more waste, and less "turn off," with a greater number of hands, being the ruinous result.

If the machinery be in bad condition, it should either be replaced with new, or thoroughly overhauled at any cost, and when it is thus renovated, it should be kept in thorough repair. Spinning frames are the better of being "lined up" about every 16 to 20 months, according to circumstances. This is required on account of the sinking of the bottom brass roller, which will occur with greater rapidity where the bottom pressing rollers have been set too much to the outside of brass roller to save it, instead of being

kept a little high, as shown by the "lines." This causes the brass roller to wear down as much as it does in. This sinking of the brass roller, besides being injurious to the spin, is very destructive to the threadplate eyes. In "lining up, the roller and other seats are looked to as well as packed ; the spindles are lined up ; the rove shifter reset ; an odd stud, wheel, or brass renewed ; and the troughs levelled. This gives two mechanics work for about two days.

A spinning frame should be thoroughly overhauled about every five to seven years, when there is all likelihood of new spindle tops, new flyers, new necks, new steps, new arbours, new brasses, new threadplate eyes, new studs, and new gearing, being required. All brass rollers should be refluted, stands and builder rods pieced, builder bosses planed, and the rove-shifting apparatus and trough and creels renewed. This would give work to four fitters and one turner for about from eight to ten days.

Speed of Spinning Frame.

The chief consideration, after these repairs are accomplished, is to keep the machinery in excellent condition by the use of the best oils, and by driving the frames as slow as is consistent with turn-off. This minimum slowness may be speedily discovered by using the following table in making out changes. The writer can confidently say, from long experience, that the standard of twists laid down for each quality of yarn is the most suitable in every respect, allowing of the minimum speed of spindles with the maximum level appearance, and strength of yarn, for its class. He can say also that if the flax be assorted according to the class of yarn required, which is simply warp flax for warp yarn, and weft flax for weft yarn, there will be no difficulty in procuring the indicated cuts per spindle for that particular lea, and with that particular twist, on the given speed of spindle ; the spinner minding two sides of line or one side of tow ; provided the machinery and accompaniments are of fair average.

Table of Spinning Cuts per Spindle.

The following table does not need much explanation except for us to point out that under the heading of "turns per inch" is the count of lea, and the number of cuts per spindle to which that quality of lea may be driven when receiving the twist indicated. This number of cuts on being found in the column immediately below, and then followed up the horizontal line to the left hand, gives the speed at which the spindle must be driven to produce these cuts—some 15 per cent. being included to cover all unavoidable loss. Or, the speed and twist being known, the resultant "cuts per spindle" are shown.

It is rather a lengthy calculation to trace out the "cuts per spindle" off a spinning frame, from the size and revolutions per minute of the boss or bottom roller ; but, if the actual twist that the yarn is receiving and the speed of the spindle be definitely known, the calculation is very simple, thus :—

Turns per inch = 17·5)	3700·0	speed of spindle.
	211·4	inch delivered per minute.
	560	minutes per day.
300 yards (1 cut) × 36 = Inches 10800)	118384·	
	10·96	gross cuts.
	1·64	= 15 per cent. off.
	9·32	actual cuts per spindle.

TABLE OF PROPORTIONATE "CUTS PER SPINDLE" PER DAY OF 9⅓ HOURS IN CONJUNCTION WITH THE SPEED OF SPINDLE AND TWIST, 15 PER CENT. BEING ALLOWED FOR LOSS BY DOFFING, STOPPAGE, WASTE, CONTRACTION BY TWIST AND REELING.

TURNS PER INCH	6	6¼	6½	6¾	7	7¼	7½	7¾	8	8¼	8½	8¾	9	9¼	9½	9¾	10
Prime Line Warp Lea	..	8's	..	..	10's	..	12's	..	..	14's	..	16's	..	18's	..	..	20's
$\surd \times 2{\cdot}2$ = Cuts	..	23	..	..	22	..	21	..	..	20	..	19	..	18	..	..	17½
Line Warp Lea	..	10's	..	..	12's	..	14's	..	16's	..	18's	..	20's	..	22's	..	25's
$\surd \times 2{\cdot}0$ = Cuts	..	24	..	..	23	..	22	..	21	..	20	..	19	..	18½	..	18
Line Warp Lea	10's	..	12's	..	14's	..	16's	..	18's	..	20's	..	22's	..	25's	..	28's
$\surd \times 1{\cdot}9$ = Cuts	25	..	24	..	23	..	22	..	21	..	20	..	19½	..	19	..	18½
Tow & Md'n Line Lea	..	12's	..	14's	..	16's	18's	..	20's	..	22's	..	25's	..	28's	30's	..
$\surd \times 1{\cdot}8$ = Cuts	..	25	..	24	..	23	22	..	21	..	20½	..	20	..	19½	19	..
Light Line Warp Lea	..	14's	..	16's	..	18's	..	20's	22's	..	25's	..	28's	30's	32's	..	35's
$\surd \times 1{\cdot}7$ = Cuts	..	25	..	24	..	23	..	22	21½	..	21	..	20½	20	19½	..	19
Line Weft Lea........	14's	..	16's	18's	..	20's	..	..	25's	..	..	30's	..	..	35's	..	38's
$\surd \times 1{\cdot}6$ = Cuts	20	..	19	18	..	17½	..	..	17	..	..	16½	..	..	16	..	15½
RVLTNS. OF SPINDLE.	CUTS PER SPINDLE.																
2500............	18·4	17·6	17·0	16·3	15·8	15·2	14·8	14·2	13·9	13·3	13·0	12·6	12·2	11·9	11·7	11·3	11·0
2600............	19·2	18·3	17·7	17·0	16·4	15·8	15·4	14·8	14·4	13·9	13·6	13·1	12·8	12·4	12·2	11·7	11·5
2700............	20·0	19·0	18·4	17·6	17·1	16·4	16·0	15·3	14·9	14·4	14·1	13·6	13·3	12·8	12·6	12·2	12·0
2800............	20·7	19·7	19·1	18·3	17·7	17·0	16·6	15·9	15·5	14·9	14·7	14·1	13·8	13·3	13·1	12·6	12·5
2900............	21·4	20·4	19·8	18·9	18·4	17·6	17·1	16·5	16·1	15·5	15·2	14·6	14·3	13·8	13·5	13·1	12·9
3000............	22·1	21·1	20·4	19·6	19·0	18·2	17·7	17·0	16·7	16·0	15·7	15·1	14·8	14·5	14·0	13·6	13·3
3100............	22·9	21·9	21·1	20·2	19·8	18·8	18·4	17·6	17·2	16·5	16·2	15·6	15·3	14·8	14·5	14·0	13·8
3200............	23·7	22·5	21·9	20·9	20·2	19·4	18·9	18·2	17·7	17·1	16·7	16·1	15·8	15·2	15·0	14·5	14·3
3300............	24·4	23·3	22·5	21·5	20·9	20·0	19·5	18·7	18·3	17·6	17·2	16·6	16·3	15·7	15·4	14·9	14·7
3100............	25·1	24·0	23·2	22·2	21·6	20·7	20·1	19·3	18·8	18·2	17·7	17·1	16·8	16·2	15·9	15·4	15·1
3500............	..	24·7	23·9	22·8	22·2	21·3	20·7	19·9	19·4	18·7	18·3	17·6	17·2	16·7	16·4	15·8	15·5
3600............	..	..	24·5	23·5	22·8	21·9	21·3	20·4	20·0	19·2	18·7	18·1	17·8	17·1	16·8	16·3	16·0
3700............	..	..	..	24·2	23·5	22·5	21·9	21·0	20·5	19·7	19·3	18·6	18·3	17·6	17·3	16·7	16·5
3800............	..	..	..	..	24·1	23·1	22·4	21·6	21·0	20·3	19·9	19·1	18·7	18·1	17·8	17·2	16·8
3900............	..	..	..	..	..	23·7	23·1	22·2	21·6	20·8	20·4	19·6	19·2	18·6	18·2	17·6	17·3
4000............	..	..	..	..	..	..	23·7	22·7	22·2	21·3	20·9	20·1	19·7	19·0	18·6	18·1	17·8
4100............	..	..	..	..	..	..	..	23·3	22·7	21·9	21·4	20·6	20·1	19·5	19·1	18·5	18·2
4200............	..	..	..	..	..	..	..	..	23·3	22·4	21·9	21·1	20·7	20·0	19·6	19·0	18·6
4300............	..	..	..	..	..	..	..	..	..	23·0	22·4	21·6	21·2	20·5	20·1	19·4	19·1
4400............	..	..	..	..	..	..	..	..	..	..	22·9	22·1	21·7	21·0	20·5	19·9	19·5
4500............	..	..	..	..	..	..	..	..	..	..	..	22·6	22·1	21·5	21·0	20·3	20·0
4600............	..	..	..	..	..	..	..	..	..	..	..	..	22·6	21·9	21·5	20·8	20·4
4700............	..	..	..	..	..	..	..	..	..	..	..	..	..	22·4	22·0	21·2	20·8
4800............	..	..	..	..	..	..	..	..	..	..	..	..	..	..	22·4	21·7	21·3
4900............	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	22·1	21·8
5000............	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	22·1
5100............	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
5200............	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
5300............	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
5400............	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
5500............	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	

TABLE OF PROPORTIONATE "CUTS PER SPINDLE."—*Continued.*

TURNS PER INCH	10¼	10½	10¾	11	11¼	11½	11¾	12	12½	13	13½	14	14½	15	15½	16	16½
Prime Line Warp Lea	..	..	..	25's	..	..	..	30's	..	35's	..	40's	45's	..	50's	..	55's
√ × 2·2 = Cuts......	..	..	..	17	..	..	..	16½	..	16	..	15½	15	..	14½	..	14
Line Warp Lea	..	..	..	30's	..	..	35's	..	40's	..	45's	50's	..	55's	60's	65's	70's
√ × 2·0 = Cuts......	..	..	..	17½	..	..	17	..	16½	..	16	15½	..	15	14½	14	13½
Line Warp Lea	..	30's	..	..	35's	..	..	40's	45's	..	50's	55's	60's	65's	..	70's	75's
√ × 1·9 = Cuts......	..	18	..	..	17½	..	..	17	16½	..	16	15½	15	14½	..	14	13½
Tow & M'dn Line Lea	32's	35's	..	..	..	40's	..	45's	50's	..	55's	60's	65's	70's	75's	80's	..
√ × 1·8 = Cuts......	18½	18	..	..	..	17½	..	17	16½	..	16	15½	15	14½	14	13½	..
Light Line Warp Lea	..	..	40's	..	..	45's	..	50's	55's	60's	..	65's	75's	80's	85's	90's	..
√ × 1·7 = Cuts......	..	..	18½	..	..	18	..	17½	17	16½	..	16	15	14½	14	13½	..
Line Weft Lea........	..	..	45's	..	50's	..	..	55's	60's	65's	70's	75's	80's	90's	..	100s	..
√ × 1·6= Cuts	..	..	15	..	14½	..	..	14	13½	13	12½	12	12	11½	..	11	..
RVLTNS. OF SPINDLE.								CUTS PER SPINDLE.									
2500............	10·7	10·5	10·2	9·9	9·8	9·6	9·4	9·2	8·8	8·6	8·2	7·9	7·6	7·4	7·1	7·0	6·8
2600............	11·2	11·0	10·6	10·3	10·2	10·1	9·7	9·6	9·2	8·9	8·6	8·3	7·9	7·7	7·4	7·2	7·0
2700............	11·6	11·4	11·0	10·7	10·6	10·5	10·1	10·0	9·6	9·2	8·9	8·6	8·3	8·0	7·7	7·4	7·2
2800............	12·0	11·8	11·5	11·1	11·0	10·9	10·6	10·4	9·9	9·5	9·2	8·8	8·6	8·3	8·0	7·7	7·5
2900............	12·5	12·3	11·9	11·5	11·4	11·3	10·9	10·8	10·3	9·9	9·5	9·2	8·9	8·6	8·3	8·0	7·8
3000............	12·9	12·7	12·3	12·0	11·7	11·6	11·2	11·0	10·7	10·2	9·9	9·5	9·1	8·9	8·6	8·3	8·1
3100............	13·3	13·1	12·7	12·3	12·1	12·0	11·6	11·4	11·0	10·6	10·2	9·9	9·5	9·1	8·9	8·5	8·3
3200............	13·7	13·5	13·1	12·7	12·5	12·4	12·0	11·8	11·3	11·0	10·5	10·1	9·8	9·4	9·1	8·8	8·6
3300............	14·2	13·9	13·5	13·2	12·9	12·8	12·4	12·2	11·7	11·2	10·8	10·5	10·1	9·7	9·4	9·1	8·8
3400............	14·6	14·4	13·9	13·6	13·3	13·1	12·7	12·6	12·1	11·5	11·1	10·8	10·4	10·1	9·7	9·4	9·1
3500............	15·0	14·7	14·3	14·0	13·7	13·5	13·1	12·9	12·4	11·9	11·5	11·0	10·7	10·4	10·0	9·6	9·4
3600............	15·5	15·2	14·7	14·4	14·1	13·9	13·5	13·3	12·8	12·2	11·8	11·4	11·0	10·7	10·3	9·9	9·7
3700............	15·9	15·6	15·2	14·8	14·5	14·3	13·9	13·7	13·1	12·6	12·2	11·7	11·3	10·9	10·6	10·2	9·9
3800............	16·3	16·1	15·6	15·2	14·9	14·6	14·2	14·1	13·5	12·8	12·5	12·0	11·6	11·3	10·8	10·5	10·2
3900............	16·8	16·5	16·0	15·6	15·3	15·0	14·6	14·5	13·8	13·2	12·8	12·4	11·9	11·5	11·1	10·8	10·5
4000............	17·2	16·9	16·4	16·0	15·7	15·4	15·0	14·8	14·2	13·5	13·1	12·6	12·3	11·8	11·4	11·0	10·7
4100............	17·6	17·3	16·8	16·4	16·0	15·8	15·4	15·1	14·6	13·9	13·5	12·9	12·6	12·1	11·7	11·3	11·0
4200............	18·0	17·7	17·2	16·8	16·4	16·2	15·7	15·5	14·9	14·3	13·8	13·3	12·8	12·5	12·0	11·6	11·3
4300............	18·5	18·2	17·6	17·2	16·8	16·6	16·1	15·9	15·2	14·6	14·2	13·6	13·1	12·7	12·3	11·9	11·6
4400............	18·9	18·6	18·0	17·6	17·2	16·9	16·5	16·3	15·6	14·9	14·5	13·9	13·5	13·0	12·6	12·2	11·8
4500............	19·3	19·1	18·4	18·0	17·6	17·4	16·9	16·7	16·0	15·2	14·8	14·3	13·8	13·3	12·8	12·5	12·1
4600............	19·8	19·5	18·8	18·4	18·0	17·8	17·2	17·0	16·4	15·6	15·1	14·5	14·1	13·6	13·1	12·7	12·4
4700............	20·2	20·0	19·3	18·8	18·4	18·2	17·6	17·4	16·7	16·0	15·4	14·8	14·4	13·9	13·4	13·0	12·7
4800............	20·6	20·3	19·7	19·3	18·8	18·5	18·0	17·8	17·0	16·4	15·8	15·2	14·6	14·2	13·7	13·2	12·9
4900............	21·0	20·7	20·0	19·7	19·2	18·9	18·4	18·1	17·4	16·6	16·1	15·5	15·0	14·5	14·0	13·5	13·2
5000............	21·5	21·1	20·5	20·0	19·6	19·3	18·7	18·4	17·7	16·9	16·6	15·8	15·3	14·7	14·3	13·8	13·4
5100............	21·9	21·6	20·9	20·5	20·0	19·7	19·1	18·8	18·1	17·3	16·8	16·2	15·6	15·0	14·6	14·1	13·7
5200............	..	22·0	21·3	20·9	20·4	20·0	19·5	19·2	18·4	17·7	17·2	16·4	15·9	15·4	14·8	14·4	14·0
5300............	..	..	21·7	21·3	20·8	20·4	19·9	19·6	18·8	18·0	17·5	16·7	16·3	15·7	15·1	14·6	14·3
5400............	..	..	..	21·7	21·2	20·9	20·2	20·0	19·1	18·3	17·9	17·1	16·6	16·0	15·4	14·9	14·6
5500............	...	..	..	..	21·6	21·1	20·6	20·4	19·5	18·6	18·2	17·4	16·9	16·3	15·8	15·2	14·8

TABLE OF PROPORTIONATE "CUTS PER SPINDLE."—*Continued.*

TURNS PER INCH.	17	17½	18	18½	19	19½	20	21	22	23	24	25	26	27	28	29	30
Prime Line Warp Lea	60's	..	65's	70's	75's	80's	..	90's	100s	110s	120s	130s	140s	150s	160s	170s	190s
$\surd \times 2{\cdot}2$ = Cuts	13½	..	13	12½	12	11½	..	11	10½	10	9½	9	8½	8	7½	7	6
Line Warp Lea	75's	..	80's	..	90's	..	100s	110s	120s	130s	140s	160s	170s	180s	200s	210s	230s
$\surd \times 2{\cdot}0$ = Cuts	13	..	12½	..	12	..	11½	11	10½	10	9½	9	8½	8	7½	7	6½
Line Warp Lea	80's	..	90's	..	100s	..	110s	120s	140s	150s	160s	170s	190s	..	220s	230s	250s
$\surd \times 1{\cdot}9$ = Cuts	13	..	12½	..	12	..	11½	11	10	9½	9	8½	7½	..	7	6½	6
Tow & Md'm Line Lea	90's	..	100s	..	110s	120s	130s	140s	150s	160s	180s	190s	210s	230s	240s	260s	280s
$\surd \times 1{\cdot}8$ = Cuts	13	..	12½	..	12	11½	11	10½	10	9½	8½	8	7½	7	6½	6	5½
Light Line Warp Lea	100s	..	110s	120s	..	130s	140s	150s	170s	180s	200s	220s	240s	250s	270s	290s	310s
$\surd \times 1{\cdot}7$ = Cuts	13	..	12½	12	..	11½	11	10½	9½	9	8	7½	7	6½	6	5½	5
Line Weft Lea........	110s	120s	130s	..	140s	150s	160s	170s	190s	210s	230s	250s	..	280s	300s	330s	350s
$\surd \times 1{\cdot}6$ = Cuts	10½	10	9½	..	9	8½	8	7½	6½	6	5½	5	..	4½	4	3½	3
RVLTNS. OF SPINDLE.	CUTS PER SPINDLE.																
2500............	6·5	6·3	6·2	6·0	5·8	5·6	5·5	5·3	5·1	4·9	4·5	4·4	4·2	4·1	3·9	3·8	3·7
2600............	6·8	6·5	6·4	6·2	6·0	5·9	5·7	5·5	5·3	5·1	4·8	4·5	4·4	4·2	4·1	3·9	3·8
2700............	7·1	6·8	6·7	6·4	6·2	6·1	6·0	5·7	5·5	5·2	5·0	4·8	4·6	4·4	4·2	4·1	4·0
2800............	7·3	7·0	6·9	6·7	6·5	6·3	6·2	5·9	5·7	5·4	5·2	5·0	4·7	4·6	4·4	4·2	4·1
2900............	7·5	7·3	7·1	6·9	6·7	6·5	6·4	6·1	5·8	5·6	5·4	5·2	4·9	4·7	4·5	4·4	4·3
3000............	7·8	7·5	7·4	7·1	6·9	6·8	6·7	6·3	6·1	5·8	5·5	5·4	5·1	4·9	4·7	4·6	4·5
3100............	8·1	7·8	7·6	7·4	7·2	7·0	6·9	6·5	6·3	6·0	5·7	5·5	5·2	5·0	4·9	4·7	4·6
3200............	8·4	8·0	7·9	7·6	7·4	7·2	7·0	6·8	6·5	6·2	5·9	5·7	5·4	5·2	5·0	4·8	4·7
3300............	8·6	8·3	8·1	7·9	7·6	7·4	7·3	7·0	6·7	6·4	6·1	5·9	5·6	5·4	5·2	5·0	4·8
3400............	8·9	8·6	8·4	8·1	7·9	7·7	7·5	7·2	6·9	6·6	6·3	6·1	5·8	5·5	5·3	5·2	5·0
3500............	9·1	8·8	8·7	8·3	8·1	7·9	7·8	7·4	7·0	6·8	6·5	6·2	5·9	5·7	5·5	5·3	5·1
3600............	9·4	9·1	8·9	8·6	8·3	8·1	8·0	7·6	7·2	6·9	6·7	6·5	6·1	5·9	5·7	5·5	5·3
3700............	9·6	9·3	9·1	8·8	8·6	8·4	8·2	7·8	7·4	7·1	6·9	6·6	6·3	6·0	5·8	5·6	5·4
3800............	9·9	9·6	9·3	9·0	8·8	8·6	8·4	8·0	7·6	7·3	7·0	6·8	6·4	6·2	6·0	5·8	5·6
3900............	10·2	9·8	9·6	9·3	9·0	8·8	8·6	8·2	7·9	7·5	7·2	7·0	6·6	6·4	6·1	5·9	5·7
4000............	10·5	10·1	9·8	9·5	9·3	9·0	8·9	8·5	8·1	7·7	7·4	7·2	6·8	6·5	6·3	6·0	5·9
4100............	10·7	10·3	10·1	9·7	9·5	9·3	9·0	8·7	8·3	7·9	7·6	7·3	6·9	6·7	6·4	6·2	6·0
4200............	10·9	10·6	10·4	10·0	9·7	9·5	9·3	8·9	8·5	8·1	7·7	7·4	7·1	6·8	6·6	6·4	6·2
4300............	11·2	10·8	10·6	10·2	10·0	9·7	9·5	9·1	8·7	8·3	7·9	7·6	7·3	7·0	6·8	6·5	6·3
4400............	11·5	11·1	10·8	10·5	10·2	9·9	9·7	9·3	8·8	8·5	8·1	7·8	7·4	7·2	6·9	6·7	6·5
4500............	11·7	11·3	11·1	10·7	10·4	10·2	10·0	9·5	9·0	8·7	8·3	8·0	7·6	7·3	7·1	6·8	6·6
4600............	12·0	11·6	11·3	10·9	10·8	10·4	10·2	9·7	9·2	8·9	8·5	8·2	7·8	7·5	7·2	7·0	6·8
4700............	12·3	11·8	11·6	11·2	11·0	10·6	10·4	9·9	9·4	9·0	8·7	8·4	8·0	7·7	7·4	7·1	6·9
4800............	12·5	12·1	11·8	11·4	11·2	10·8	10·7	10·2	9·7	9·2	8·9	8·6	8·1	7·8	7·5	7·3	7·0
4900............	12·7	12·3	12·1	11·7	11·4	11·1	10·8	10·4	9·9	9·4	9·0	8·7	8·3	8·0	7·7	7·4	7·2
5000............	13·0	12·6	12·3	11·9	11·7	11·3	11·0	10·6	10·1	9·6	9·2	8·8	8·5	8·1	7·8	7·6	7·3
5100............	13·3	12·8	12·6	12·1	11·9	11·5	11·3	10·8	10·3	9·8	9·4	9·0	8·6	8·3	8·0	7·7	7·5
5200............	13·6	13·1	12·8	12·4	12·2	11·7	11·5	11·0	10·5	10·0	9·6	9·2	8·8	8·5	8·2	7·9	7·6
5300............	13·8	13·3	13·0	12·6	12·4	12·0	11·7	11·2	10·7	10·2	9·8	9·4	9·0	8·6	8·3	8·0	7·8
5400............	14·1	13·6	13·3	12·8	12·6	12·2	12·0	11·4	10·8	10·4	10·0	9·6	9·1	8·8	8·5	8·2	7·9
5500............	14·4	13·8	13·5	13·1	12·8	12·4	12·2	11·6	11·0	10·6	10·2	9·8	9·3	9·0	8·6	8·3	8·0

Spinning Twists.

It will be noticed that the twist requisite for the various qualities of yarn is widely different. For example 14's lea prime warp is to be twisted $2\frac{1}{4}$ turns per inch harder than the same lea of wefts; and this great difference increases proportionately as the counts become finer, 190's lea prime warp, getting as much as 8 turns per inch more twist than the same lea of weft. The reason for this is, that good fibre is improved by twist, the yarn looks rounder and more level and will last longer; whereas poor fibre will not bear twisting to nearly so great an extent, as the greater proportion of the twist passes into the "shires" and weak places in the yarn, making it brittle and weak.

Again, to give much twist to yarn and at the same time procure a good "turn-off," requires a quick spindle, which only warps can stand to advantage. Less twist may imply the same turn-off with a slower spindle. Besides, where the yarn is of poor quality, it will look better, and be actually stronger, with being slack twisted.

The cuts per spindle is the length of yarn that will be delivered with the indicated turns per inch and speed of spindle, if not more than 15 per cent. be lost by doffing, stoppage, including bands and flyers-off and rollers out; contraction by twist; waste; and reeling. This percentage should be the limit in any case, as if yarn be coarse, and there is thus more waste, there is less contraction by twist than if it be fine, and little waste, but great contraction. The 15 per cent. is made up of about 8 per cent. for doffing and stoppage, 4 per cent. for waste, 2 per cent. for contraction by twist, and 1 per cent. of loss between the yarn spun and the yarn reeled.

The standard twist for warp yarns is the square root of the lea multiplied by 2, which gives the standard turns per inch for that lea, but, as is seen by the preceding "turn-off table" and the "table of twists" which follows, some yarns only get their square root multiplied by 1·5, whilst others require it multiplied by 3·0, to give them the requisite "thread-like" appearance.

Spinning Drafts.

In making out the draft on which any yarn is to be spun a great deal depends upon the degree of twist, on account of the contraction which it causes. Hard twisted yarns require to be spun on a longer draft than slack twisted yarns, to keep them to the correct weight. It is scarcely necessary to remark here that the standard number for finding the draft of yarn is 18·75, which is simply an abbreviation of the following calculation :—300yds. of yarn in one cut or lea, divided by 16, the ounces in one pound, gives 18·75, the number of yards of yarn per ounce to one "cut" or "lea" of one pound weight.

This number (18·75), to which may be added from one to twelve per cent. (according to the amount of loss that is likely to occur in the spinning, from poverty of material, in contradistinction to the amount gained by contraction by twist) gives a "standing number," which when multiplied by the lea to be drafted, and the result divided by the yards per ounce of rove of that lea, will give the requisite spinning draft.

18·75+

1	2	3	4	5	6	7	8	9	10	11	12 per cent.
=18·93	19·13	19·31	19·49	19·68	19·87	20·06	20·25	20·44	20·62	20·81	21·00

TABLE OF TWISTS.—TURNS PER INCH.

Lea.	Square Root.	× 1·5	× 1·6	× 1·7	× 1·8	× 1·9	× 2·0	× 2·2	× 2·5	× 3·0
8's	2·83	4·2	4·5	4·8	5·1	5·4	5·6	6·2	7·1	8·5
9's	3·00	4·5	4·8	5·1	5·4	5·7	6·0	6·6	7·5	9·0
10's	3·16	4·7	5·0	5·4	5·7	6·0	6·3	7·0	7·9	9·5
11's	3·32	5·0	5·3	5·6	6·0	6·3	6·6	7·3	8·3	9·9
12's	3·46	5·2	5·5	5·9	6·2	6·6	6·9	7·6	8·6	10·4
13's	3·60	5·4	5·7	6·1	6·4	6·8	7·2	7·9	9·0	10·8
14's	3·74	5·6	5·9	6·3	6·6	7·0	7·4	8·2	9·3	11·2
16's	4·00	6·0	6·4	6·8	7·2	7·6	8·0	8·8	10·0	12·0
18's	4·24	6·4	6·8	7·2	7·6	8·0	8·5	9·3	10·6	12·7
20's	4·47	6·7	7·2	7·7	8·1	8·6	9·0	9·9	11·3	13·1
22's	4·69	7·0	7·5	8·0	8·4	8·9	9·4	10·3	11·7	14·5
25's	5·00	7·5	8·0	8·5	9·0	9·5	10·0	11·0	12·5	15·0
28's	5·29	7·9	8·4	9·0	9·5	10·0	10·6	11·6	13·2	15·9
30's	5·48	8·2	8·7	9·3	9·8	10·4	10·9	12·0	13·7	16·4
32's	5·66	8·5	9·0	9·6	10·2	10·7	11·3	12·4	14·1	17·0
35's	5·92	8·9	9·5	10·0	10·6	11·2	11·8	13·0	14·8	17·8
38's	6·17	9·2	9·9	10·5	11·1	11·7	12·3	13·6	15·4	18·5
40's	6·33	9·5	10·1	10·7	11·4	12·0	12·7	13·9	15·7	19·0
45's	6·71	10·0	10·7	11·4	12·1	12·7	13·4	14·7	16·8	20·1
50's	7·07	10·6	11·3	12·0	12·7	13·4	14·1	15·5	17·7	21·2
55's	7·42	11·1	11·9	12·6	13·3	14·1	14·8	16·3	18·5	22·2
60's	7·75	11·6	12·4	13·2	13·9	14·7	15·5	17·0	19·4	23·2
65's	8·06	12·1	12·9	13·7	14·5	15·3	16·1	17·7	20·1	24·2
70's	8·37	12·5	13·4	14·2	15·1	15·9	16·7	18·4	20·9	25·1
75's	8·66	13·0	13·8	14·7	15·6	16·4	17·3	19·0	21·6	26·0
80's	8·94	13·4	14·3	15·2	16·1	17·0	17·9	19·7	22·3	26·8
85's	9·22	13·8	14·7	15·7	16·6	17·5	18·4	20·3	23·0	27·6
90's	9·49	14·2	15·2	16·1	17·1	18·0	19·0	20·9	23·7	28·5
95's	9·75	14·6	15·6	16·6	17·6	18·5	19·5	21·4	24·4	29·2
100's	10·00	15·0	16·0	17·0	18·0	19·0	20·0	22·0	25·0	30·0
110's	10·49	15·7	16·8	17·8	18·9	19·9	21·0	23·1	26·2	31·5
120's	10·95	16·4	17·5	18·6	19·7	20·8	21·9	24·1	27·4	32·8
130's	11·40	17·1	18·2	19·4	20·5	21·7	22·8	25·1	28·5	34·2
140's	11·83	17·7	18·9	20·1	21·3	22·5	23·6	26·0	29·6	35·5
150's	12·25	18·4	19·6	20·8	22·0	23·3	24·5	26·9	30·6	36·7
160's	12·65	19·0	20·2	21·5	22·8	24·0	25·3	27·8	31·6	37·9
170's	13·04	19·6	20·8	22·2	23·5	24·8	26·1	28·7	32·6	39·1
180's	13·41	20·1	21·4	22·8	24·1	25·5	26·8	29·5	33·5	40·2
190's	13·79	20·7	22·0	23·4	24·8	26·2	27·6	30·3	34·5	41·4
200's	14·14	21·2	22·6	24·0	25·4	26·9	28·2	31·1	35·3	42·4
210's	14·49	21·7	23·2	24·6	26·0	27·5	29·0	31·9	36·2	43·5
220's	14·82	22·2	23·7	25·2	26·7	28·1	29·6	32·6	37·0	44·4
230's	15·16	22·7	24·2	25·8	27·3	28·8	30·3	33·3	38·0	45·5
240's	15·49	23·2	24·8	26·3	27·8	29·4	31·0	34·1	38·7	46·5
250's	15·81	23·7	25·3	26·9	28·5	30·0	31·6	34·8	39·5	47·4
260's	16·12	24·2	25·8	27·4	29·0	30·6	32·2	35·4	40·3	48·4
270's	16·43	24·6	26·3	27·9	29·6	31·2	32·8	36·1	41·1	49·3
280's	16·73	25·1	26·7	28·4	30·1	31·8	33·4	36·8	41·8	50·2
290's	17·03	25·5	27·2	28·9	30·6	32·3	34·0	37·5	42·6	51·1
300's	17·32	25·9	27·7	29·4	31·2	32·9	34·6	38·1	43·3	52·0

Making due allowance for all contingencies. we compiled the following table, which, after daily making use of for years, we can pronounce to be practically correct for all general spinning drafting purposes.

Draft Multiplicand Table.

SPINNING DRAFT MULTIPLICAND TABLE,

For different quality and lea of yarn of all twists.

10's to 18's	20's to 40's	45 s to 65's	70's to 150's	160's to 300's	Lea Line Warp.
14's to 30's	35's to 65's	70's to 110's	120's to 240's	250's to 350's	Lea Line Weft and Tows.
,,	,,	18·8	19·2	19·6=for 5 turns slack.	
,,	,,	19·0	19·4	19·8= ,, 4 ,, ,,	
,,	18·9	19·2	19·6	20·0= ,, 3 ,, ,,	
18·8	19·1	19·4	19·8	20·1= ,, 2 ,, ,,	
18·9	19·2	19·5	19·9	20·2= ,, 1 ,, ,,	
19·0	19·3	19·6	20·0	20·3= ,, full warp twist.	
19·2	19·5	19·7	20·1	20·4= ,, 1 turns tight,	
19·4	19·6	19·8	20·2	20·5= ,, 2 ,, ,,	
19·6	19·8	20·0	20·3	20·6= ,, 3 ,, ,,	
19·8	20·0	20·2	20·4	20·7= ,, 4 ,, ,,	
,,	20·2	20·4	20·6	20·8= ,, 5 ,, ,,	
,,	,,	20·6	20·8	21·0= ,, 6 ,, ,,	
,,	,,	20·8	21·0	21·2= ,, 7 ,, ,,	

Tables of Spinning Drafts.

Overlookers in coarse spinning rooms, to simplify matters, generally make use of the one "constant number" 19, those in medium rooms take the number 19·5, and those in fine rooms use 20. These numbers come near enough to the mark for general purposes, and it is upon a generalisation of this sort that we now give three tables of spinning drafts (pp. 184 to 189) calculated upon the basis of 19·0 or one per cent. for contraction in coarse numbers; 19·5 or four per cent. for the medium numbers; and 20·0 or seven per cent. for the fine numbers.

This set of draft tables will be found more convenient, as well as more accurate, than if all were combined in one, as no single establishment in the flax spinning trade comprises the whole range of wet-spun yarn, consequently in none shall there be found any necessity for the use of more than one, or at most two of these tables. They will be found especially handy as a reference, when consulting the table of line yarn gradations (page 190) as to the practicability of drafting a particular weight of rove to spin a yarn of extraordinary lea.

TABLE OF COARSE SPINNING "DRAFTS," UPON THE BASIS OF ONE PER CENT. ALLOWANCE.

Yards per oz.	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
Leas 8's ..	6·1	5·8	5·6	5·4	5·2	5·1	4·9	4·7	4·6	4·5	4·3	4·2	4·1	4·0	3·9	..	..	..	..	..	..	..	..
10's ..	7·6	7·3	7·0	6·8	6·5	6·3	6·1	5·9	5·7	5·6	5·4	5·2	5·1	5·0	4·9	4·7	4·6	4·5	4·4	4·3	4·2	4·1	4·0
12's ..	9·1	8·8	8·4	8·1	7·9	7·6	7·3	7·1	6·9	6·7	6·5	6·3	6·2	6·0	5·8	5·7	5·5	5·4	5·3	5·2	5·1	4·9	4·8
14's ..	10·6	10·2	9·8	9·5	9·2	8·9	8·6	8·3	8·1	7·8	7·6	7·4	7·2	7·0	6·8	6·6	6·5	6·3	6·2	6·0	5·9	5·8	5·6
16's ..	12·2	11·7	11·3	10·9	10·5	10·1	9·8	9.5	9·2	8·9	8·7	8·4	8·2	8·0	7·8	7·6	7·4	7·2	7·1	6·9	6·8	6·6	6·4
18's ..	13·7	13·1	12·7	12·2	11·8	11·4	11·0	10·7	10·4	10·1	9·8	9·5	9·2	9·0	8·8	8·5	8·3	8·1	7·9	7·8	7·6	7·4	7·3
20's ..	15·2	14·6	14·1	13·6	13·1	12·7	12·2	11·9	11·5	11·2	10·8	10·5	10·3	10·0	9·7	9·5	9·3	9·0	8·8	8·6	8·4	8·3	8·1
22's ..	16·7	16·1	15·5	14·9	14·4	13·9	13·5	13·1	12·7	12·3	11·9	11·6	11·3	11·0	10·7	10·4	10·2	9·9	9·7	9·5	9·3	9·1	8·9
25's ..	..	..	..	17·0	16·4	15·8	15·3	14·8	14·4	14·0	13·6	13·2	12·8	12·5	12·2	11·9	11·6	11·3	11·0	10·8	10·5	10·3	10·1
28's ..	..	..	..	..	..	..	17·2	16·6	16·1	15·6	15·2	14·8	14·4	14·0	13·6	13·3	13·0	12·6	12·4	12·1	11·8	11·6	11·3
30's ..	..	..	..	..	..	..	..	..	..	16·8	16·3	15·9	15·4	15·0	14·6	14·2	13·9	13·6	13·2	12·9	12·7	12·4	12·2
32's ..	..	..	..	..	..	..	..	..	..	..	..	..	16·4	16·0	15·6	15·2	14·8	14·5	14·1	13·8	13·5	13·2	12·9
35's ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	16·6	16·2	15·8	15·4	15·1	14·8	14·4	14·1
38's ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	16·8	16·4	16 0	15·7	15·6
40's ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	16·5	16·2

TABLE OF COARSE SPINNING "DRAFTS,"—*Continued.*

Yards per oz.	48	49	50	51	52	53	54	55	56	57	58	59	60	62	64	66	68	70	72	74	76	78	80
Leas 8's ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
10's ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
12's ..	4·7	4·6	4·5	4·4	4·3	4·2	4·1	4·0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
14's ..	5·5	5·4	5·3	5·2	5·1	5·0	4·9	4·8	4·7	4·6	4·5	4·4	4·3	4·2	4·1	4·0	..	..	..	..	..	..	..
16's ..	6·3	6·2	6·1	5·9	5·8	5·7	5·6	5·5	5·4	5·3	5·2	5·1	5·0	4·9	4·8	4·7	4·6	4·5	4·4	4·3	4·2	4·1	4·0
18's ..	7·1	7·0	6·8	6·7	6·6	6·4	6·3	6·2	6·1	6·0	5·9	5·8	5·7	5·5	5·3	5·2	5·0	4·9	4·7	4·6	4·5	4·4	4·2
20's ..	7·9	7·7	7·6	7·4	7·3	7·2	7·0	6·9	6·8	6·7	6·5	6·4	6·3	6·1	5·9	5·7	5·6	5·4	5·3	5·1	5·0	4·9	4·7
22's ..	8·7	8·5	8·4	8·2	8·0	7·9	7·7	7·6	7·5	7·3	7·2	7·1	7·0	6·7	6·5	6·3	6·1	6·0	5·8	5·6	5·5	5·3	5·2
25's ..	9·9	9·7	9·5	9·3	9·1	9·0	8·8	8·6	8·5	8·3	8·2	8·0	7·9	7·6	7·4	7·2	7·0	6·7	6·6	6·4	6·2	6·1	5·9
28's ..	11·1	10·9	10·6	10·4	10·2	10·0	9·8	9·7	9·5	9·3	9·2	9·0	8·7	8·6	8·3	8·1	7·8	7·6	7·4	7·2	7·0	6·8	6·6
30's ..	11·9	11·6	11·4	11·2	10·9	10·7	10·5	10·3	10·2	10·0	9·8	9·7	9·5	9·2	8·9	8·6	8·4	8·1	7·9	7·7	7·5	7·3	7·1
32's ..	12·7	12·4	12·1	11·9	11·7	11·5	11·2	11·0	10·8	10·7	10·5	10·3	10·1	9·8	9·5	9·2	8·9	8·7	8·4	8·2	8 0	7·8	7·6
35's ..	13·8	13·6	13·3	13·0	12·8	12·6	12·3	12·1	11·9	11·7	11·5	11·3	11·1	10·7	10·4	10·1	9·8	9·5	9·2	9·0	8·7	8·5	8·3
38's ..	15·1	14·7	14·4	14·1	13·9	13·6	13·3	13·1	12·9	12·7	12·4	12·2	12·0	11·6	11·3	10·9	10·6	10·3	10·0	9·8	9·5	9·3	9·0
40's ..	15·8	15·5	15·2	14·9	14·6	14·3	14·0	13·8	13·6	13·3	13·1	12·9	12·7	12·2	11·9	11·5	11·2	10·8	10·6	10·3	10·0	9·7	9·5

TABLE OF MEDIUM SPINNING "DRAFTS," UPON THE BASIS OF FOUR PER CENT. ALLOWANCE.

Yards per oz.	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128
Leas 30's	7·3	7·1	7·0	6·8	6·6	6·5	6·3	6·1	6·0	5·9	5·8	5·7	5·6	5·5	5·4	5·3	5·2	5·1	5·0	4·9	4·8	4·8	4·7	4·6	4·5
,, 35's	8·5	8·3	8·1	7·9	7·7	7·6	7·4	7·3	7·1	7·0	6·8	6·7	6·6	6·4	6·3	6·2	6·1	6·0	5·9	5·8	5·7	5·6	5·5	5·4	5·3
,, 40's	9·7	9·5	9·3	9·1	8·9	8·7	8·5	8·3	8·1	7·9	7·8	7·6	7·5	7·3	7·2	7·1	7·0	6·8	6·7	6·6	6·5	6·4	6·3	6·2	6·1
,, 45's	11·0	10·7	10·4	10·2	10·0	9·7	9·5	9·3	9·1	8·9	8·8	8·6	8·4	8·3	8·1	8·0	7·8	7·7	7·6	7·4	7·3	7·2	7·1	7·0	6·8
,, 50's	12·2	11·9	11·6	11·3	11·1	10·8	10·6	10·4	10·1	9·9	9·8	9·5	9·4	9·2	9·0	8·9	8·7	8·5	8·4	8·3	8·1	8·0	7·9	7·7	7·6
,, 55's	13·4	13·1	12·8	12·5	12·2	11·9	11·6	11·4	11·2	10·9	10·8	10·5	10·3	10·1	9·9	9·7	9·6	9·4	9·2	9·1	8·9	8·8	8·6	8·5	8·4
,, 60's	14·6	14·3	13·9	13·6	13·3	13·0	12·7	12·4	12·2	11·9	11·8	11·4	11·2	11·0	10·8	10·6	10·4	10·3	10·1	9·9	9·7	9·6	9·4	9·3	9·1
,, 65's	15·8	15·4	15·1	14·7	14·4	14·1	13·8	13·5	13·2	12·9	12·7	12·4	12·2	11·9	11·7	11·5	11·3	11·1	10·9	10·7	10·5	10·4	10·2	10·1	9·9
,, 70's	17·1	16·6	16·2	15·9	15·5	15·2	14·8	14·5	14·2	13·9	13·6	13·4	13·1	12·9	12·6	12·4	12·2	12·0	11·8	11·6	11·4	11·2	11·0	10·8	10·7
,, 75's	18·3	17·8	17·4	17·0	16·6	16·2	15·9	15·6	15·2	14·9	14·6	14·3	14·0	13·8	13·5	13·3	13·0	12·8	12·6	12·4	12·2	12·0	11·8	11·6	11·4
,, 80's	..	..	..	..	..	..	16·9	16·6	16·2	15·9	15·6	15·3	15·0	14·7	14·4	14·2	13·9	13·7	13·4	13·2	13·0	12·8	12·6	12·4	12·2
,, 85's	..	..	..	..	..	..	18·0	17·6	17·3	16·9	16·6	16·2	15·9	15·6	15·3	15·1	14·8	14·5	14·3	14·0	13·8	13·6	13·4	13·1	13·0
,, 90's	..	..	..	..	..	..	..	..	..	..	..	..	16·9	16·5	16·2	15·9	15·7	15·6	15·1	14·9	14·6	14·4	14·1	13·9	13·7
,, 95's	..	..	..	..	..	..	..	..	..	..	..	..	17·8	17·5	17·1	16·8	16·5	16·2	16·0	15·7	15·4	15·2	14·9	14·7	14·5
,, 100's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	16·8	16·5	16·2	16·0	15·7	15·5	15·2
,, 105's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	17·6	17·3	17·1	16·8	16·5	16·2	16·0
,, 110's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	...	16·8
,, 115's	..	..	..	:	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	17·5
,, 120's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

TABLE OF MEDIUM SPINNING "DRAFTS,"—*Continued.*

Yards per oz.	130	132	134	136	138	140	142	144	146	148	150	152	154	156	158	160	162	165	168	170	172	175	178	180
Leas 30's	4·4	4·3	4·3	4·2	4·1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
,, 35's	5·2	5·2	5·1	5·0	4·9	4·9	4·8	4·7	4·7	4·6	4·5	..	..	..	..	..	..	..	..	..	..	..	..	..
,, 40's	6·0	5·9	5·8	5·7	5·6	5·6	5·5	5·4	5·3	5·3	5·2	5·1	5·1	5·0	4·9	4·9	4·8	..	..	..	..	..	..	..
,, 45's	6·7	6·6	6·5	6·4	6·3	6·3	6·2	6·1	6·0	5·9	5·8	5·8	5·7	5·6	5·5	5·5	5·4	5·3	5·2	5·2	5·1	5·0	4·9	4·9
,, 50's	7·5	7·4	7·3	7·2	7·1	7·0	6·9	6·8	6·7	6·6	6·5	6·4	6·3	6·2	6·2	6·1	6·0	5·9	5·8	5·7	5·7	5·6	5·5	5·4
,, 55's	8·2	8·1	8·0	7·9	7·8	7·6	7·5	7·4	7·3	7·2	7·1	7·0	7·0	6·9	6·8	6·7	6·6	6·5	6·4	6·3	6·2	6·1	6·0	6·0
,, 60's	9·0	8·9	8·7	8·6	8·5	8·3	8·2	8·1	8·0	7·9	7·8	7·7	7·6	7·5	7·4	7·3	7·2	7·1	7·0	6·9	6·8	6·7	6·6	6·5
,, 65's	9·7	9·6	9·4	9·3	9·2	9·0	8·9	8·8	8·7	8·6	8·4	8·3	8·2	8·1	8·0	7·9	7·8	7·7	7·5	7·4	7·3	7·2	7·1	7·0
,, 70's	10·5	10·3	10·2	10·0	9·9	9·7	9·6	9·5	9·3	9·2	9·1	9·0	8·9	8·7	8·6	8·5	8·4	8·3	8·1	8·0	7·9	7·8	7·7	7·6
,, 75's	11·2	11·1	10·9	10·7	10·6	10·4	10·3	10·1	10·0	9·9	9·7	9·6	9·5	9·4	9·2	9·1	9·0	8·9	8·7	8·6	8·5	8·3	8·2	8·1
,, 80's	12·0	11·8	11·6	11·5	11·3	11·1	11·0	10·8	10·7	10·5	10·4	10·2	10·1	10·0	9·9	9·7	9·6	9·4	9·3	9·2	9·1	8·9	8·8	8·7
,, 85's	12·7	12·6	12·4	12·2	12·0	11·8	11·7	11·5	11·3	11·2	11·0	10·9	10·7	10·6	10·5	10·3	10·2	10·0	9·9	9·7	9·6	9·5	9·3	9·2
,, 90's	13·5	13·3	13·1	12·9	12·7	12·5	12·4	12·2	12·0	11·9	11·7	11·5	11·4	11·2	11·1	11·0	10·8	10·6	10·4	10·3	10·2	10·0	9·9	9·7
,, 95's	14·2	14·0	13·8	13·6	13·4	13·2	13·0	12·9	12·7	12·5	12·3	12·2	12·0	11·9	11·7	11·6	11·4	11·2	11·0	10·9	10·8	10·6	10·4	10·3
,, 100's	15·0	14·8	14·5	14·3	14·1	13·9	13·7	13·5	13·3	13·2	13·0	12·8	12·7	12·5	12·3	12·2	12·0	11·8	11·6	11·5	11·3	11·1	10·9	10·8
,, 105's	15·7	15·5	15·3	15·0	14·8	14·6	14·4	14·2	14·0	13·8	13·6	13·5	13·3	13·1	12·9	12·8	12·6	12·4	12·2	12·0	11·9	11·7	11·5	11·4
,, 110's	16·5	16·2	16·0	15·8	15·5	15·3	15·1	14·9	14·7	14·5	14·3	14·1	13·9	13·7	13·6	13·4	13·2	13·0	12·8	12·6	12·5	12·2	12·0	11·9
,, 115's	17·2	17·0	16·7	16·5	16·2	16·0	15·8	15·6	15·4	15·1	14·9	14·7	14·5	14·4	14·2	14·0	13·8	13·6	13·3	13·2	13·0	12·8	12·6	12·5
,, 120's	..	..	..	..	..	16·7	16·5	16·3	16·0	15·7	15·5	15·3	15·1	15·0	14·8	14·6	14·4	14·2	13·9	13·7	13·5	13·4	13·2	13·1

TABLE OF FINE SPINNING "DRAFTS" UPON THE BASIS OF SEVEN PER CENT. ALLOWANCE.

Yds. per oz.	180	185	190	195	200	205	210	215	220	225	230	235	240	245	250	255	260
Leas. 110's	12·2	11·9	11·6	11·3	11·0	10·7	10·5	10·2	10·0	9·8	9·6	9·4	9·2	9·0	8·8	8·6	8·5
120's	13·3	13·0	12·6	12·3	12·0	11·7	11·4	11·2	10·9	10·7	10·4	10·2	10·0	9·8	9·6	9·4	9·2
130's	14·4	14·0	13·7	13·3	13·0	12·7	12·4	12·1	11·8	11·5	11·3	11·1	10·8	10·6	10·4	10·2	10·0
140's	15·5	15·1	14·7	14·4	14·0	13·7	13·3	13·0	12·7	12·4	12·2	11·9	11·7	11·4	11·2	11·0	10·8
150's	16·6	16·2	15·8	15·4	15·0	14·6	14·3	13·9	13·6	13·3	13·0	12·8	12·5	12·2	12·0	11·8	11·5
160's	17·8	17·3	16·8	16·4	16·0	15·6	15·2	14·9	14·5	14·2	13·9	13·6	13·3	13·1	12·8	12·5	12·3
170's	..	..	..	..	..	16·6	16·2	15·8	15·4	15·1	14·8	14·5	14·2	13·9	13·6	13·3	13·1
180's	..	..	..	..	..	17·6	17·1	16·8	16·3	16·0	15·6	15·3	15·0	14·7	14·4	14·1	13·8
190's	..	..	..	..	..	..	..	..	..	..	16·5	16·2	15·8	15·5	15·2	14·9	14·6
200's	..	..	..	..	..	..	..	..	..	..	17·4	17·0	16·7	16·3	16·0	15·7	15·4
210's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	16·5	16·1
220's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	17·2	16·9
230's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
240's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
250's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
260's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
270's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
280's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
290's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
300's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
310's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
320's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
330's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
340's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
350's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

TABLE OF FINE SPINNING "DRAFTS."—*Continued.*

Yds. per oz.	265	270	275	280	285	290	295	300	305	310	315	320	325	330	335	340	345
Leas. 110's	8·3	8·1	8·0	7·8	7·7	7·6	7·4	7·3	7·2	7·1	7·0	6·9	6·8	6·7	6·6	6·5	6·4
120's	9·0	8·9	8·7	8·6	8·4	8·3	8·1	8·0	7·9	7·7	7·6	7·5	7·4	7·3	7·2	7·0	6·9
130's	9·8	9·6	9·4	9·3	9·1	9·0	8·8	8·7	8·5	8·4	8·3	8·1	8·0	7·9	7·8	7·6	7·5
140's	10·6	10·4	10·2	10·0	9·8	9·6	9·5	9·3	9·2	9·0	8·9	8·7	8·6	8·5	8·3	8·2	8·1
150's	11·3	11·1	10·9	10·7	10·5	10·3	10·2	10·0	9·8	9·7	9·5	9·4	9·2	9·1	8·9	8·8	8·7
160's	12·1	11·8	11·6	11·4	11·2	11·0	10·8	10·7	10·5	10·3	10·2	10·0	9·8	9·6	9·5	9·4	9·3
170's	12·8	12·6	12·4	12·1	11·9	11·7	11·5	11·3	11·1	11·0	10·8	10·6	10·4	10·3	10·1	10·0	9·8
180's	13·6	13·3	13·1	12·8	12·6	12·4	12·2	12·0	11·8	11·6	11·4	11·2	11·1	10·9	10·7	10·6	10·4
190's	14·3	14·1	13·8	13·6	13·3	13·1	12·9	12·7	12·5	12·2	12·1	11·9	11·7	11·5	11·3	11·2	11·0
200's	15·1	14·8	14·5	14·3	14·0	13·8	13·5	13·3	13·1	12·9	12·7	12·5	12·3	12·1	11·9	11·8	11·6
210's	15·8	15·5	15·2	15·0	14·7	14·5	14·2	14·0	13·8	13·5	13·3	13·1	12·9	12·7	12·5	12·3	12·2
220's	16·6	16·3	16·0	15·7	15·4	15·2	14·9	14·7	14·4	14·2	14·0	13·7	13·5	13·3	13·1	12·9	12·7
230's	..	..	..	16·4	16·1	15·9	15·6	15·3	15·1	14·8	14·6	14·4	14·1	13·9	13·7	13·5	13·3
240's	..	..	..	17·1	16·8	16·5	16·3	16·0	15·7	15·5	15·2	15·0	14·8	14·5	14·3	14·1	13·9
250's	..	..	..	..	..	..	..	..	16·4	16·1	15·9	15·6	15·3	15·1	14·9	14·7	14·4
260's	..	..	..	..	..	..	..	..	17·0	16·8	16·6	16·3	16·0	15·7	15·5	15·3	15·1
270's	..	..	..	..	..	..	..	..	..	..	..	..	..	16·4	16·1	15·9	15·6
280's	..	..	..	..	..	..	..	..	..	..	..	..	..	16·9	16·7	16·4	16·2
290's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
300's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
310's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
320's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
330's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
340's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
350's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

TABLE OF FINE SPINNING "DRAFTS."—*Continued.*

Yds. per oz.	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500
Leas 110's	6·3	6·1	5·9	5·8	5·6	5·5	5·4	5·2	5·1	5·0	4·9	4·8	4·7	4·6	4·5	4·4
120's	6·8	6·7	6·5	6·3	6·1	6·0	5·8	5·7	5·6	5·4	5·3	5·2	5·1	5·0	4·9	4·8
130's	7·4	7·2	7·0	6·8	6·7	6·5	6·3	6·2	6·0	5·9	5·8	5·6	5·5	5·4	5·3	5·2
140's	8·0	7·8	7·6	7·4	7·2	7·0	6·8	6·7	6·5	6·4	6·2	6·1	6·0	5·8	5·7	5·6
150's	8·6	8·3	8·1	7·9	7·7	7·5	7·3	7·1	7·0	6·8	6·7	6·5	6·4	6·2	6·1	6·0
160's	9·1	8·9	8·6	8·4	8·2	8·0	7·8	7·6	7·4	7·3	7·1	6·9	6·8	6·7	6·5	6·4
170's	9·7	9·4	9·2	8·9	8·7	8·5	8·3	8·1	7·9	7·7	7·5	7·4	7·2	7·1	6·9	6·8
180's	10·3	10·0	9·7	9·5	9·2	9·0	8·8	8·6	8·4	8·2	8·0	7·8	7·6	7·5	7·3	7·2
190's	10·8	10·5	10·3	10·0	9·8	9·5	9·3	9·0	8·8	8·6	8·4	8·3	8·1	7·9	7·7	7·6
200's	11·4	11·1	10·8	10·6	10·3	10·0	9·7	9·5	9·3	9·1	8·9	8·7	8·5	8·3	8·2	8·0
210's	12·0	11·7	11·3	11·1	10·8	10·5	10·2	10·0	9·8	9·5	9·3	9·1	8·9	8·7	8·6	8·4
220's	12·6	12·2	11·9	11·6	11·3	11·0	10·7	10·5	10·2	10·0	9·8	9·6	9·3	9·2	9·0	8·8
230's	13·1	12·8	12·4	12·1	11·8	11·5	11·2	10·9	10·7	10·5	10·2	10·0	9·8	9·6	9·4	9·2
240's	13·7	13·3	13·0	12·7	12·3	12·0	11·7	11·4	11·2	10·9	10·7	10·4	10·2	10·0	9·8	9·6
250's	14·3	13·9	13·5	13·2	12·8	12·5	12·2	11·9	11·6	11·4	11·1	10·9	10·6	10·4	10·2	10·0
260's	14·8	14·4	14·0	13·7	13·4	13·0	12·7	12·4	12·1	11·8	11·5	11·3	11·0	10·8	10·6	10·4
270's	15·4	15·0	14·6	14·2	13·9	13·5	13·2	12·8	12·5	12·3	12·0	11·7	11·5	11·2	11·0	10·8
280's	16·0	15·5	15·1	14·8	14·4	14·0	13·7	13·3	13·0	12·7	12·4	12·2	11·9	11·7	11·4	11·2
290's	16·6	16·1	15·7	15·3	14·9	14·5	14·1	13·8	13·5	13·2	12·9	12·6	12·3	12·1	11·8	11·6
300's	..	16·6	16·2	15·8	15·4	15·0	14·6	14·3	14·0	13·6	13·3	13·0	12·7	12·5	12·2	12·0
310's	..	..	16·7	16·3	15·9	15·5	15·1	14·8	14·4	14·1	13·8	13·5	13·2	12·9	12·6	12·4
320's	..	..	..	16·9	16·4	16·0	15·6	15·2	14·9	14·5	14·2	13·9	13·6	13·3	13·1	12·8
330's	..	..	..	..	16·9	16·5	16·1	15·7	15·3	15·0	14·6	14·3	14·0	13·7	13·5	13·2
340's	..	..	..	..	..	17·0	16·6	16·2	15·8	15·4	15·1	14·8	14·4	14·2	13·9	13·6
350's	..	..	..	..	..	..	17·1	16·7	16·3	15·9	15·5	15·2	14·9	14·6	14·3	14·0

GRADATION OF LEA-LINE YARNS.

Warp (standa'd)	Super Warp.	Prime Warp.	Extra Warp.	Medium Warp.	Light Warp.	Prime Weft.	Extra Weft.	Weft.
Full warp Twist = $\surd \times 2{\cdot}0$.	= $\surd \times 3{\cdot}0$.	= $\surd \times 2{\cdot}2$.	= $\surd \times 2{\cdot}1$	= $\surd \times 1{\cdot}9$.	= $\surd \times 1{\cdot}8$.	= $\surd \times 1{\cdot}7$.	= $\surd \times 1{\cdot}6$.	= $\surd \times 1{\cdot}5$.
22's	11's	14's	20's	25's	28's	30's	32's	35's
25's	12's	16's	22's	28's	30's	32's	35's	40's
28's	13's	18's	25's	30's	32's	35's	40's	45's
30's	14's	20's	28's	32's	35's	40's	45's	50's
32's	16's	22's	30's	35's	40's	45's	50's	55's
35's	18's	25's	32's	40's	45's	50's	55's	60's
38's	20's	28's	35's	45's	50's	55's	60's	70's
40's	22's	30's	38's	50's	55's	60's	65's	80's
42's	25's	32's	40's	55's	60's	65's	70's	90's
45's	28's	35's	42's	60's	65's	70's	80's	100's
48's	30's	38's	45's	65's	70's	75's	90's	110's
50's	32's	40's	48's	70's	75's	80's	100's	120's
55's	35's	42's	50's	75's	80's	90's	110's	130's
60's	38's	45's	55's	80's	85's	100's	120's	140's
65's	40's	50's	60's	85's	90's	110's	130's	150's
70's	42's	55's	65's	90's	100's	120's	140's	160's
75's	45's	60's	70's	95's	110's	130's	150's	170's
80's	48's	65's	75's	100's	120's	140's	160's	180's
90's	50's	70's	80's	110's	130's	150's	170's	190's
100's	55's	75's	85's	120's	140's	160's	180's	200's
110's	60's	80's	90's	130's	150's	170's	190's	220's
120's	65's	85's	100's	140's	160's	180's	200's	240's
130's	70's	90's	110's	150's	170's	190's	220's	260's
140's	75's	95's	120's	160's	180's	200's	240's	280's
150's	80's	100's	130's	170's	190's	220's	260's	300's
160's	85's	110's	140's	180's	200's	240's	280's	330's
170's	90's	120's	150's	190's	220's	260's	300's	350's
180's	95's	130's	160's	200's	240's	280's	330's	380's
190's	100's	140's	170's	220's	260's	300's	350's	400's
200's	110's	150's	180's	240's	280's	330's	380's	430's

This gradation (the draft being feasible) will be found well regulated as regards spinning quality, if the "reach" and the "cuts per spindle" be altered to suit. Of course, as before remarked upon, it would be far better if each quality of yarn were spun out of a like quality of fibre; but where the proprietor is anxious to fill all orders at the shortest possible notice, this could not be accomplished, even at the expense of keeping up a very varied, and consequently large dressed line stock.

How to produce unusual "Counts."

With reference to the driving of a spinning frame, we would remark that the speed of the spindle being given, it is an easy matter to find the size of pulleys required for that frame by multiplying the average revolutions per minute of the driving shaft by the diameter of drum, then the result thus obtained by the diameter of cylinder divided by the diameter of wharve; the sum thus obtained, divided by the revolutions of spindle per minute, will give the diameter in inches of pulley required to give that speed of spindle. Example:—

Pulleys of Spinning-frame.

```
                          240 driving shaft revolutions per minute.
                           30in. diameter of drum.
                          ----
                          7200
                           8·0 standing number of 12in. cylinder and 1½in wharve.
Revolutions of            ------
    spindle,  = 4000·0)57600·0
                        -------
                          14·4 or say pulleys of 14½in. diameter.
```

The difficulty of uneven sizes of pulley (as the size of pulleys rises by one inch), can generally be regulated by a judicious selection of the twist wheel to work in concert, as the dividing of the required twist into the constant number for twist also generally gives odd teeth, the twist wheel rising two teeth at a time. Thus, if there be smaller pulleys than the calculation put on, the nearest smaller twist wheel to that required by calculation can be put on, and *vice versa*.

Sizes of Pulleys and Twist Wheels.

But nevertheless we would strongly recommend the sizes of pulleys from 10in. diameter (the smallest pulley any belt should have to drive) to 15in. rising by half inches, and from 15in. up by inches; and any twist wheels of less than 40 teeth to size to one tooth; as 1in. or two teeth in these small pulleys and twist wheels, represents a very large percentage of the whole. Why we limit the size of the smallest pulley to 10in. is that the belt will have so little bearing on one of less diameter, and at the same time be so much compressed on the inside and stretched on the outside as to cause the leather to give the minimum of wear; also the belt has to be put on so tight as to be injurious not only to itself, but to the driving-shaft, guide-pulley and cylinder bearings.

In changing drums or pulleys, a simple rule for finding the requisite increase or diminution to be made in the length of the driving belt is to add or subtract, as the case may be, the difference and half the difference of the diameter of the drum or pulley to be changed.

Changing Drums and Pulleys.

The reader will have remarked in the preceding calculation a "standing number" for cylinder and wharve, this is merely the cylinder diameter divided by the wharve diameter, to expedite matters. The following table will embrace nearly, if not all, the standing numbers of the various sizes of cylinder and wharve:—

Constant No. for Cylinder and Wharve.

TABLE OF CONSTANT NUMBERS FOR DIFFERENT DIAMETERS OF CYLINDER AND WHARVE.

DIAMETER OF WHARVE.	in. $\frac{7}{8}$	in. $\frac{9}{10}$	in. $\frac{15}{16}$	in. $\frac{31}{32}$	in. 1	in. $1\frac{1}{32}$	in. $1\frac{1}{16}$	in. $1\frac{1}{12}$	in. $1\frac{1}{10}$	in. $1\frac{1}{8}$	in. $1\frac{2}{12}$
Cylinder Diameter. 8in. ÷ Wharve Diameter =	9·1	8·9	8·6	8·3	8·0	7·7	7·5	7·3	7·1	7·0	6·8
9in. ,, ,, =	10·3	10·0	9·6	9·3	9·0	8·7	8·5	8·3	8·2	8·0	7·7
10in. ,, ,, =	11·4	11·1	10·6	10·3	10·0	9·7	9·4	9·2	9·1	8·9	8·6
11in. ,, ,, =	12·6	12·2	11·7	11·3	11·0	10·7	10·4	10·2	10·0	9·8	9·4
12in. ,, ,, =	13·7	13·3	12·8	12·4	12·0	11·6	11·3	11·1	10·9	10·7	10·3
13in. ,, ,, =	14·9	14·4	13·8	13·5	13·0	12·6	12·3	12·0	11·8	11·6	11·2

TABLE OF CONSTANT NUMBERS FOR DIFFERENT DIAMETERS OF CYLINDER AND WHARVE—*Continued.*

DIAMETER OF WHARVE.	in. $1\frac{3}{16}$	in. $1\frac{2}{16}$	in. $1\frac{7}{32}$	in. $1\frac{1}{4}$	in. $1\frac{3}{16}$	in. $1\frac{5}{16}$	in. $1\frac{4}{12}$	in. $1\frac{3}{8}$	in. $1\frac{5}{12}$	in. $1\frac{7}{16}$	in. $1\frac{15}{32}$	in. $1\frac{1}{2}$
Cylinder Diameter. 8in. Wharve Diameter =	6·7	6·6	6·5	6·4	6·1	6·0	5·9	5·7	5·6	5·5	5·4	5·3
9in. ,, ,, =	7·6	7·5	7·4	7·2	6·9	6·8	6·7	6·5	6·3	6·2	6·1	6·0
10in. ,, ,, =	8·4	8·3	8·2	8·0	7·7	7·6	7·5	7·3	7·0	6·9	6·8	6·7
11in. ,, ,, =	9·3	9·2	9·0	8·8	8·5	8·4	8·2	8·0	7·7	7·6	7·5	7·3
12in. ,, ,, =	10·1	10·0	9·8	9·6	9·2	9·1	9·0	8·7	8·5	8·3	8·1	8·0
13in. ,, ,, =	11·0	10·8	10·6	10·4	9·9	9·8	9·7	9·4	9·2	9·0	8·8	8·7

Although in this table there are many sizes of wharve given to each size of cylinder, yet it does not follow that there is no proper proportion to be maintained between the cylinder and the wharve. In reality, it is very essential to give this matter due consideration, thus :—

Proportion between Cylinder and Wharve.

A cylinder of large diameter cannot advantageously be driven at so great speed as a small one, on account of vibration, consequently it is not desirable to speed up the spindle by the circumferential velocity of the cylinder without any regard to the size of wharve, as the large cylinder driven proportionately slower than a small one, will only give about the same revolutions of spindle, the wharve being in both cases similar. And besides, the large cylinder would be a decided disadvantage, the angle of the band being so obtuse as to incline to rub on the side of the wharve, producing a bouncing spindle, and greater wear and tear on the bandcord from friction.

This generation of unnecessary heat is very injurious, as it causes an increase in the heat of the wharve, whence it extends to the butt, and to the neck journal of the spindle.

This shows the necessity of a large wharve in connection with a large cylinder, to work with minimum friction, which results in a slow spindle, and is therefore only suitable for coarse numbers and frames.

The best proportions for cylinder and wharve are—

	3in.	$2\frac{3}{4}$in.	$2\frac{1}{2}$in.	$2\frac{1}{4}$in.	2in.	$1\frac{3}{4}$in.	Pitch of frame.
Cylinder....	13in.	12in.	11in.	10in.	9in.	8in.	diameter.
Wharve....	$1\frac{1}{2}$in.	$1\frac{4}{10}$in.	$1\frac{3}{10}$in.	$1\frac{2}{10}$in.	$1\frac{1}{10}$in.	$\frac{9}{10}$in.	diameter.

For this reason the width of a spinning frame from side to side is of moment; the broader the better, where it will not obstruct the light, and where there is room. This insures the minimum friction between band and wharve.

Table of Spinning Frame Turn-off.

As being of much use in expeditiously posting-up a set of books called "frame books," which show the class and amount of yarn produced by each spinning frame daily, we give a table (pp. 194 to 196) showing the yarn reeled per frame. This table will also be found useful for general reference.

Spindles in Frame.

We cannot forbear remarking that if this table does not embrace all the sizes of wet spinning frames, so much the worse for those persons who may have to work with frames either shorter or longer, for the following reasons:—If there be fewer than 128 spindles in the frame, no matter how coarse, it is a matter of impossibility to drive it at a speed sufficient to procure a turn-off commensurate with the expense entailed in having it properly minded. On the other hand, if it be a frame of more than 300 spindles, no matter how fine in the pitch, it will be found next to impossible to get the two sides minded by one woman, and at the same time to drive it at a speed sufficient to procure a turn-off proportionate to the lea; or, if the charge be one side, to put on speed sufficient to cover the extra outlay of paying nearly the same wages for the minding of one side as of two. Speed must always bear some relation to the length and strength of the brass or "bottom" roller. When this roller is of such exceeding length as is needful to cover one hundred and fifty, even of the finest, spindles, there is a torsional strain upon it which produces vibration and thus militates against the spin, in the case of poor wefts making them unspinnable on that frame.

It is easy to perceive that this result will nullify any apparent advantage gained by getting an extra number of spindles into a side.

Then arises the question, What is the best size of spinning frame for all practical purposes? This is easily answered from the knowledge that a fair average breadth of spinning room is forty-five feet in clear; allowing an over-all length of twenty feet for each frame, and plenty of space besides for the pass and columns, the latter to range about two feet off the centre line of spinning room. A frame of about twenty feet over-all, will admit the following number of spindles:—

3 inch.	$2\frac{3}{4}$ inch.	$2\frac{1}{2}$ inch.	$2\frac{1}{4}$ inch.	2 inch.	$1\frac{3}{4}$ inch pitch.
136	148	161	180	204	240 spindles.

Height of Spinning Rooms.

Having remarked as to the proper breadth of a spinning room, we may here say something as to its height. If the ceiling be too low the health of the workers will be injured by the closeness, heat and impurity of the air they breathe. This is especially the case when the gas is lighted, and generally makes it a matter of necessity for them to open the air-panes of the windows, thus often causing draughts in the room, than which nothing is worse for the "spin." To avoid these evils millowners often fly into the opposite extreme of having the room too lofty; this is a great evil, as there has to be a much greater consumption of steam to keep the room up to the requisite temperature, which is not only expensive but becomes injurious to the spin from the fact of the water being excessively hot. Besides, as the condensation is so much greater in a lofty apartment, the whole room—floors, walls, and ceiling—is bathed in wet, soon destroying all woodwork and plaster and corroding the iron beams, columns, and tie-rods; in fact making it a matter of impossibility to keep the building in any sort of cleanliness and repair.

TABLE OF CUTS PER SPINDLE PER DAY, ON REELS, PER WEEK OF SIX DAYS.

Reels per week. ☞		35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
Spindles	128	10·9	11·2	11·5	11·8	12·1	12·5	12·8	13·1	13·4	13·7	14·1	14·4	14·7	15·0	15·3	15·6	15·9	16·2	16·5
,,	132	10·6	10·9	11·2	11·5	11·8	12·1	12·4	12·7	13·0	13·3	13·6	13·9	14·2	14·5	14·8	15·1	15·4	15·7	16·1
,,	136	10·3	10·6	10·8	11·1	11·4	11·6	11·9	12·1	12·4	12·7	13·2	13·5	13·8	14·1	14·4	14·7	15·0	15·3	15·6
,,	140	10·0	10·3	10·5	10·8	11·1	11·4	11·7	12·0	12·2	12·5	12·8	13·1	13·4	13·7	14·0	14·3	14·6	14·8	15·1
,,	144	9·7	10·0	10·2	10·5	10·8	11·1	11·4	11·7	12·0	12·2	12·5	12·8	13·0	13·3	13·6	13·9	14·2	14·4	14·7
,,	148	9·4	9·7	10·0	10·2	10·5	10·8	11·1	11·3	11·6	11·9	12·1	12·4	12·7	13·0	13·2	13·5	13·8	14·0	14·3
,,	152	9·1	9·4	9·7	9·9	10·2	10·5	10·8	11·0	11·3	11·6	11·8	12·1	12·3	12·6	12·9	13·1	13·4	13·6	13·9
,,	156	8·9	9·2	9·4	9·7	10·0	10·2	10·5	10·7	11·0	11·3	11·5	11·8	12·0	12·3	12·6	12·9	13·1	13·3	13·6
,,	160	8·7	9·0	9·2	9·5	9·7	10·0	10·2	10·5	10·7	11·0	11·2	11·5	11·7	12·0	12·2	12·5	12·7	13·3	13·2
,,	164	8·5	8·7	9·0	9·2	9·5	9·7	10·0	10·2	10·5	10·7	11·0	11·2	11·5	11·7	11·9	12·2	12·4	12·7	12·9
,,	168	8·3	8·5	8·8	9·0	9·3	9·5	9·7	10·0	10·2	10·5	10·7	10·9	11·2	11·4	11·7	11·9	12·1	12·4	12·6
,,	172	8·2	8·3	8·6	8·8	9·1	9·3	9·5	9·7	10·0	10·2	10·4	10·7	10·9	11·2	11·4	11·6	11·8	12·1	12·3
,,	176	7·9	8·1	8·4	8·6	8·8	9·1	9·3	9·5	9·8	10·0	10·2	10·4	10·7	10·9	11·1	11·4	11·5	11·8	12·0
,,	180	7·7	8·0	8·2	8·4	8·6	8·9	9·1	9·3	9·5	9·8	10·0	10·2	10·4	10·7	10·9	11·1	11·3	11·5	11·8
,,	184	7·6	7·8	8·0	8·2	8·4	8·7	8·9	9·1	9·3	9·5	9·8	10·0	10·2	10·5	10·7	10·9	11·1	11·3	11·5
,,	188	7·4	7·6	7·8	8·0	8·3	8·5	8·7	8·9	9·1	9·3	9·6	9·8	10·0	10·2	10·4	10·6	10·8	11·0	11·3
,,	192	7·3	7·5	7·7	7·9	8·1	8·3	8·5	8·7	8·9	9·2	9·4	9·6	9·8	10·0	10·2	10·4	10·6	10·8	11·0
,,	196	7·1	7·3	7·5	7·7	7·9	8·1	8·3	8·6	8·8	9·0	9·2	9·4	9·6	9·8	10·0	10·2	10·4	10·6	10·8
,,	200	7·0	7·2	7·4	7·6	7·8	8·0	8·2	8·4	8·6	8·8	9·0	9·2	9·4	9·6	9·8	10·0	10·2	10·4	10·6
,,	204	6·9	7·1	7·3	7·5	7·7	7·9	8·1	8·3	8·5	8·7	8·9	9·1	9·3	9·5	9·6	9·8	10·1	10·2	10·4
,,	208	6·8	7·0	7·2	7·4	7·6	7·8	8·0	8·2	8·3	8·5	8·7	8·9	9·1	9·3	9·5	9·7	9·9	10·1	10·3
,,	212	6·7	6·9	7·1	7·3	7·5	7·7	7·8	8·1	8·2	8·4	8·6	8·8	9·0	9·2	9·4	9·6	9·8	10·0	10·2
,,	216	6·6	6·8	7·0	7·2	7·3	7·6	7·7	7·9	8·1	8·3	8·5	8·7	8·8	9·1	9·2	9·4	9·7	9·8	10·0
,,	220	6·5	6·7	6·9	7·1	7·2	7·5	7·6	7·8	8·0	8·2	8·4	8·6	8·7	8·9	9·1	9·3	9·5	9·7	9·9
,,	224	6·4	6·6	6·8	7·0	7·1	7·4	7·5	7·7	7·9	8·1	8·3	8·4	8·6	8·8	9·0	9·2	9·4	9·5	9·7
,,	228	6·3	6·5	6·7	6·8	7·0	7·3	7·4	7·6	7·8	8·0	8·1	8·3	8·5	8·7	8·9	9·0	9·3	9·4	9·6
,,	232	6·2	6·4	6·6	6·7	6·9	7·1	7·3	7·5	7·7	7·8	8·0	8·2	8·4	8·6	8·7	8·9	9·1	9·3	9·4
,,	236	6·1	6·3	6·5	6·6	6·8	7·0	7·2	7·4	7·5	7·7	7·9	8·1	8·3	8·4	8·6	8·8	9·0	9·1	9·3
,,	240	6·0	6·2	6·4	6·5	6·7	6·9	7·1	7·3	7·4	7·6	7·8	7·9	8·1	8·3	8·5	8·6	8·8	9·0	9·2
,,	244	5·9	6·1	6·3	6·4	6·6	6·8	7·0	7·2	7·3	7·5	7·7	7·8	8·0	8·2	8·3	8·5	8·7	8·8	9·0
,,	248	5·8	6·0	6·2	6·3	6·5	6·7	6·9	7·0	7·2	7·4	7·5	7·7	7 9	8·1	8·2	8·4	8·6	8·7	8·9
,,	252	5·7	5·9	6·1	6·2	6·4	6·6	6·8	6·9	7·1	7·3	7·4	7·6	7·7	7·9	8·1	8·2	8·4	8·6	8·7
,,	256	5·7	5·8	6·0	6·1	6·3	6·5	6·6	6·8	7·0	7·1	7·3	7·5	7·6	7·8	8·0	8·1	8·3	8·4	8·6
,,	260	5·6	5·7	5·9	6·0	6·2	6·4	6·5	6·7	6·9	7·0	7·2	7·3	7·5	7·7	7·8	8·0	8·1	8·3	8·5
,,	264	5·5	5·6	5·8	5·9	6·1	6·3	6·4	6·6	6·7	6·9	7·0	7·2	7·4	7·5	7·7	7·8	8·0	8·2	8·3
,,	268	5·4	5·5	5·7	5·8	6·0	6·2	6·3	6·5	6·6	6·8	6·9	7·1	7·2	7·4	7·6	7·7	7·9	8·0	8·2
,,	272	5·3	5·4	5·5	5·7	5·9	6·1	6·2	6·4	6·5	6·7	6·8	7·0	7·1	7·3	7·4	7·6	7·7	7·9	8·0
,,	276	5·2	5·3	5·5	5·6	5·8	6·0	6·1	6·3	6·4	6·5	6·7	6·8	7·0	7·1	7·3	7·4	7·6	7·8	7·9
,,	280	5·1	5·2	5·4	5·5	5·7	5·8	6·0	6·1	6·3	6·4	6·6	6·7	6·9	7·0	7·2	7·3	7·5	7·6	7·8
,,	284	5·0	5·1	5·3	5·4	5·6	5·7	5·9	6·0	6·2	6·3	6·5	6·6	6·7	6·9	7·0	7·2	7·3	7·5	7·6
,,	288	4·9	5·1	5·2	5·3	5·5	5·6	5·8	5·9	6·1	6·2	6·3	6·5	6·6	6·8	6·9	7·0	7·2	7·3	7·5
,,	292	4·8	5·0	5·1	5·2	5·4	5·5	5·7	5·8	5·9	6·1	6·2	6·4	6·5	6·6	6·8	6·9	7·1	7·2	7·3
,,	296	4·7	4·9	5·0	5·1	5·3	5·4	5·6	5·7	5·8	6·0	6·1	6·2	6·4	6·5	6·7	6·8	6·9	7·1	7·2
,,	300	4·6	4·8	4·9	5·0	5·2	5·3	5·5	5·6	5·7	5·9	6·0	6·1	6·3	6·4	6·5	6·7	6·8	6·9	7·1

TABLE OF CUTS PER SPINDLE.—*Continued.*

Reels per week. ☞	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
Spindles 128	16·9	17·2	17·5	17·8	18·1	18·4	18·7	19·0	19·4	19·7	20·0	20·3	20·6	20·9	21·2	21·5	21·8	22·2	22·5
,, 132	16·4	16·7	17·0	17·3	17·6	17·9	18·2	18·5	18·8	19·1	19·4	19·7	20·0	20·3	20·6	20·9	21·2	21·5	21·8
,, 136	15·9	16·2	16·5	16·8	17·0	17·3	17·6	17·9	18·2	18·5	18·8	19·1	19·4	19·7	20·0	20·3	20·6	20·9	21·2
,, 140	15·4	15·7	16·0	16·3	16·6	16·9	17·1	17·4	17·7	18·0	18·3	18·6	18·8	19·1	19·4	19·7	20·0	20·3	20·6
,, 144	15·0	15·3	15·5	15·8	16·1	16·4	16·7	17·0	17·2	17·5	17·8	18·1	18·3	18·6	18·9	19·2	19·4	19·7	20·0
,, 148	14·6	14·8	15·1	15·4	15·7	15·9	16·2	16·5	16·7	17·0	17·3	17·6	17·8	18·1	18·4	18·6	18·9	19·2	19·4
,, 152	14·2	14·4	14·7	14·9	15·2	15·5	15·7	16·0	16·2	16·5	16·8	17·0	17·3	17·6	17·8	18·1	18·3	18·6	18·9
,, 156	13·8	14·1	14·4	14·6	14·9	15·1	15·4	15·6	15·9	16·2	16·4	16·7	16·9	17·2	17·4	17·7	17·9	18·2	18·4
,, 160	13·5	13·7	14·0	14·2	14·5	14·9	15·0	15·2	15·5	15·7	16·0	16·2	16·5	16·7	17·0	17·2	17·5	17·7	18·0
,, 164	13·2	13·4	13·7	13·9	14·1	14·4	14·6	14·9	15·1	15·4	15·6	15·8	16·1	16·3	16·6	16·8	17·1	17·3	17·5
,, 168	12·8	13·1	13·3	13·6	13·8	14·0	14·3	14·5	14·7	15·0	15·2	15·5	15·7	15·9	16·2	16·4	16·7	16·9	17·1
,, 172	12·5	12·8	13·0	13·2	13·5	13·7	13·9	14·2	14·4	14·6	14·9	15·1	15·3	15·6	15·8	16·0	16·3	16·5	16·5
,, 176	12·3	12·5	12·7	12·9	13·2	13·4	13·6	13·8	14·1	14·3	14·5	14·8	15·0	15·2	15·4	15·7	15·9	16·1	16·3
,, 180	12·0	12·2	12·4	12·7	12·9	13·1	13·3	13·5	13·8	14·0	14·2	14·4	14·6	14·9	15·1	15·3	15·5	15·8	16·0
,, 184	11·7	11·9	12·1	12·4	12·6	12·8	13·0	13·2	13·5	13·7	13·9	14·1	14·3	14·5	14·8	15·0	15·2	15·4	15·6
,, 188	11·5	11·7	11·9	12·1	12·3	12·5	12·7	13·0	13·2	13·4	13·6	13·8	14·0	14·2	14·4	14·7	14·9	15·1	15·3
,, 192	11·3	11·5	11·8	12·0	12·2	12·4	12·6	12·8	13·0	13·2	13·4	13·6	13·8	14·0	14·2	14·5	14·7	14·9	15·1
,, 196	11·0	11·2	11·4	11·6	11·8	12·0	12·2	12·4	12·6	12·8	13·0	13·3	13·5	13·7	13·9	14·1	14·3	14·5	14·7
,, 200	10·8	11·0	11·2	11·4	11·6	11·8	12·0	12·2	12·4	12·6	12·8	13·0	13·2	13·4	13·6	13·8	14·0	14·2	14·4
,, 204	10·6	10·8	11·0	11·2	11·4	11·6	11·8	12·0	12·2	12·4	12·6	12·8	13·0	13·2	13·4	13·6	13·8	14·0	14·2
,, 208	10·5	10·7	10·9	11·1	11·3	11·5	11·7	11·8	12·0	12·2	12·4	12·6	12·8	13·0	13·2	13·4	13·6	13·8	14·0
,, 212	10·4	10·5	10·7	10·9	11·1	11·3	11·5	11·7	11·9	12·1	12·3	12·5	12·7	12·8	13·0	13·2	13·4	13·6	13·8
,, 216	10·2	10·4	10·6	10·8	11·0	11·1	11·3	11·5	11·7	11·9	12·1	12·3	12·5	12·7	12·9	13·0	13·2	13·4	13·6
,, 220	10·1	10·2	10·4	10·6	10·8	11·0	11·2	11·4	11·6	11·8	11·9	12·1	12·3	12·5	12·7	12·9	13·0	13·2	13·4
,, 224	10·0	10·1	10·3	10·5	10·7	10·8	11·0	11·2	11·4	11·6	11·8	12·0	12·2	12·4	12·6	12·7	12·9	13·0	13·2
,, 228	9·8	9·9	10·1	10·3	10·5	10·7	10·9	11·0	11·2	11·4	11·6	11·8	12·0	12·1	12·3	12·5	12·7	12·8	13·0
,, 232	9·6	9·8	10·0	10·2	10·4	10·5	10·7	10·9	11·1	11·2	11·4	11·6	11·8	11·9	12·1	12·3	12·5	12·7	12·8
,, 236	9·5	9·6	9·8	10·0	10·2	10·4	10·5	10·7	10·9	11·1	11·2	11·4	11·6	11·8	12·0	12·1	12·3	12·5	12·7
,, 240	9·3	9·5	9·7	9·9	10·0	10·2	10·3	10·5	10·7	10·9	11·1	11·3	11·4	11·6	11·8	12·0	12·1	12·3	12·5
,, 244	9·2	9·4	9·5	9·7	9·9	10·0	10·2	10·4	10·6	10·7	10·9	11·1	11·3	11·4	11·6	11·8	11·9	12·1	12·3
,, 248	9·1	9·2	9·4	9·6	9·7	9·9	10·1	10·2	10·4	10·6	10·7	10·9	11·1	11·2	11·4	11·6	11·7	11·9	12·1
,, 252	8·9	9·1	9·2	9·4	9·6	9·7	9·9	10·1	10·2	10·4	10·6	10·7	10·9	11·1	11·2	11·4	11·5	11·7	11·9
,, 256	8 8	8·9	9·1	9·3	9·4	9·6	9·7	9·9	10·1	10·2	10·4	10·6	10·7	10·9	11·0	11·2	11·4	11·5	11·7
,, 260	8·6	8·8	8·9	9·1	9·3	9·4	9·6	9·7	9·8	10·0	10·2	10·4	10·6	10·7	10·9	11·0	11·2	11·3	11·5
,, 264	8·5	8·6	8·8	9·0	9·1	9·3	9·4	9·6	9·7	9·9	10·1	10·2	10·4	10·5	10·7	10·8	11·0	11·1	11·3
,, 268	8·3	8·5	8·6	8·8	9·0	9·1	9·3	9·4	9·6	9·7	9·9	10·0	10·2	10·3	10·5	10·7	10·8	11·0	11·1
,, 272	8·2	8·3	8·5	8.6	8·8	9·0	9·1	9·3	9·4	9·6	9·7	9·9	10·0	10·2	10·3	10·5	10·6	10·8	10·9
,, 276	8·1	8·2	8·4	8·5	8·6	8·8	9·0	9·1	9·2	9·4	9·5	9·7	9·8	10·0	10·1	10·3	10·5	10·6	10·7
,, 280	7·9	8·1	8·2	8·4	8·5	8·6	8·8	8·9	9·1	9·2	9·4	9·5	9·7	9·8	10·0	10·1	10·3	10·4	10·5
,, 284	7·8	7·9	8·1	8·2	8·3	8·5	8·6	8·8	8·9	9·1	9·2	9·3	9·5	9·6	9·8	9·9	10·1	10·2	10·3
,, 288	7·6	7·7	7·9	8·0	8·2	8·3	8·5	8·6	8·8	8·9	9·0	9·2	9·3	9·5	9·6	9·7	9·9	10·0	10·2
,, 292	7·5	7·6	7·7	7·9	8·0	8·2	8·3	8·4	8·6	8·7	8·9	9·0	9·1	9·3	9·4	9·6	9·7	9·8	10·0
,, 296	7·3	7·5	7·6	7·7	7·9	8·0	8·2	8·3	8·4	8·6	8·7	8·8	9·0	9·1	9·2	9·4	9·5	9·6	9·8
,, 300	7·2	7·3	7·5	7·6	7·8	7·9	8·0	8·1	8·3	8·4	8·5	8·7	8·8	8·9	9·1	9·2	9·3	9·5	9·6

TABLE OF CUTS PER SPINDLE.—*Continued.*

Reels per week. ☞	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Spindles 128	22·8	23·1	23·4	23·7	24·0	24·3	24·7	25·0	25·3	25·6	25·9	26·2	26·5	26·8	27·2	27·5	27·8	28·1
,, 132	22·1	22·4	22·7	23·0	23·3	23·6	23·9	24·2	24·5	24·8	25·1	25·4	25·7	26·0	26·3	26·6	27·0	27·3
,, 136	21·5	21·7	22·0	22·3	22·6	22·9	23·2	23·5	23·8	24·1	24·4	24·7	25·0	25·3	25·6	25·9	26·2	26·5
,, 140	20·8	21·1	21·4	21·7	22·0	22·3	22·6	22·8	23·1	23·4	23·7	24·0	24·3	24·6	24·8	25·1	25·4	25·7
,, 144	20·3	20·5	20·8	21·1	21·4	21·7	21·9	22·2	22·5	22·8	23·1	23·3	23·6	23·9	24·2	24·5	24·7	25·0
,, 148	19·7	20·0	20·2	20·5	20·8	21·1	21·3	21·6	21·9	22·1	21·4	22·7	23·0	23·2	23·5	23·8	24·0	24·3
,, 152	19·1	19·4	19·7	19·9	20·2	20·4	20·7	21·0	21·2	21·5	21·7	22·0	22·3	22·5	22·8	23·0	23·3	23·6
,, 156	18·7	18·9	19·2	19·5	19·7	20·0	20·2	20·5	20·7	21·0	21·3	21·5	21·8	22·0	22·2	22·5	22·8	23·0
,, 160	18·2	18·5	18·7	19·0	19·2	19·5	19·7	20·0	20·2	20·5	20·7	21·0	21·2	21·5	21·7	22·0	22·2	22·5
,, 164	17·8	18·0	18·2	18·5	18·8	19·0	19·3	19·5	19·7	20·0	20·2	20·6	20·8	21·1	21·3	21·6	21·8	22·0
,, 168	17·4	17·6	17·8	18·1	18·3	18·6	18·8	19·0	19·3	19·5	19·7	20·0	20·2	20·5	20·7	20·9	21·2	21·4
,, 172	16·9	17·2	17·4	17·6	17·9	18·1	18·3	18·6	18·8	19·1	19·4	19·6	19·8	20·1	20·3	20·5	20·7	21·0
,, 176	16·6	16·8	17·0	17·2	17·5	17·7	17·9	18·2	18·4	18·6	18·8	19·1	19·3	19·5	19·7	20·0	20·2	20·4
,, 180	16·2	16·4	16·6	16·9	17·1	17·3	17·5	17·8	18·0	18·2	18·4	18·6	18·9	19·1	19·3	19·5	19·8	20·0
,, 184	15·8	16·1	16·3	16·5	16·7	16·9	17·2	17·4	17·6	17·8	18·0	18·2	18·5	18·7	18·9	19·1	19·3	19·5
,, 188	15·5	15·7	15·9	16·1	16·4	16·6	16·8	17·0	17·2	17·4	17·6	17·8	18·0	18·3	18·5	18·7	18·9	19·1
,, 192	15·3	15·5	15·7	15·9	16·1	16·3	16·5	16·7	16·9	17·2	17·4	17·6	17·8	18·0	18·2	18·4	18·6	18·8
,, 196	14·9	15·1	15·3	15·5	15·7	15·9	16·1	16·3	16·5	16·7	16·9	17·1	17·3	17·5	17·7	17·9	18·2	18·4
,, 200	14·6	14·8	15·0	15·2	15·4	15·6	15·8	16·0	16·2	16·4	16·6	16·8	17·0	17·2	17·4	17·6	17·8	18·0
,, 204	14·4	14·6	14·8	15·0	15·2	15·4	15·6	15·8	16·0	16·2	16·4	16·6	16·8	17·0	17·2	17·4	17·5	17·8
,, 208	14·2	14·4	14·6	14·8	15·0	15·2	15·4	15·5	15·8	16·0	16·2	16·3	16·5	16·7	16·9	17·1	17·3	17·5
,, 212	14·0	14·2	14·4	14·6	14·8	15·0	15·1	15·3	15·5	15·7	16·0	16·1	16·3	16·5	16·7	16·9	17·1	17·3
,, 216	13·8	14·0	14·2	14·4	14·6	14·7	14·9	15·1	15·3	15·5	15·7	15·9	16·1	16·3	16·5	16·6	16·8	17·0
,, 220	13·6	13·8	14·0	14·2	14·3	14·5	14·7	14·9	15·1	15·3	15·5	15·7	15·9	16·0	16·2	16·4	16·6	16·8
,, 224	13·4	13·6	13·8	14·0	14·2	14·3	14·5	14·7	14·9	15·1	15·2	15·4	15·6	15·8	16·0	16·2	16·4	16·5
,, 228	13·2	13·4	13·6	13·7	14·0	14·1	14·3	14·5	14·7	14·9	15·0	15·2	15·4	15·6	15·8	15·9	16·1	16·3
,, 232	13·0	13·2	13·4	13·5	13·7	13·9	14·1	14·3	14·5	14·6	14·8	15·0	15·2	15·3	15·5	15·7	15·9	16·1
,, 236	12·8	13·0	13·2	13·3	13·5	13·7	13·9	14·0	14·2	14·4	14·6	14·8	14·9	15·1	15·3	15·5	15·6	15·8
,, 240	12·6	12·8	13·0	13·1	13·3	13·5	13·7	13·8	14·0	14·2	14·4	14·5	14·7	14·9	15·1	15·2	15·4	15·6
,, 244	12·4	12·6	12·8	13·0	13·1	13·3	13·5	13·6	13·8	14·0	14·2	14·3	14·5	14·7	14·8	15·0	15·2	15·4
,, 248	12·2	12·4	12·6	12·7	12·9	13·1	13·2	13·4	13·6	13·8	14·0	14·1	14·3	14·4	14·6	14·8	15·0	15·1
,, 252	12·1	12·2	12·4	12·5	12·7	12·9	13·0	13·2	13·4	13·6	13·7	13·9	14·0	14·2	14·4	14·5	14·7	14·9
,, 256	11·9	12·0	12·2	12·3	12·5	12·7	12·8	13·0	13·2	13·3	13·5	13·7	13·8	14·0	14·1	14·3	14·5	14·6
,, 260	11·7	11·8	12·0	12·1	12·3	12·5	12·6	12·7	13·0	13·1	13·3	13·4	13·6	13·7	13·9	14·1	14·2	14·4
,, 264	11·5	11·6	11·8	11·9	12·1	12·3	12·4	12·5	12·7	12·9	13·0	13·2	13·4	13·5	13·7	13·8	14·0	14·1
,, 268	11·3	11·4	11·6	11·7	11·9	12·1	12·2	12·3	12·5	12·7	12·8	13·0	13·1	13·3	13·4	13·6	13·8	13·9
,, 272	11·1	11·2	11·4	11·5	11·7	11·8	12·0	12·1	12·3	12·4	12·6	12·7	12·9	13·1	13·2	13·4	13·5	13·7
,, 276	10·9	11·0	11·2	11·3	11·5	11·6	11·8	11·9	12·1	12·2	12·4	12·5	12·7	12·8	13·0	13·1	13·3	13·4
,, 280	10·7	10·8	11·0	11·1	11·3	11·4	11·6	11·7	11·9	12·0	12·2	12·3	12·4	12·6	12·7	12·9	13·0	13·2
,, 284	10·5	10·6	10·8	10·9	11·1	11·2	11·4	11·5	11·7	11·8	12·0	12·1	12·2	12·4	12·5	12·7	12·8	13·0
,, 288	10·3	10·4	10·6	10·7	10·9	11·0	11·1	11·3	11·4	11·6	11·7	11·9	12·0	12·1	12·3	12·4	12·6	12·7
,, 292	10·1	10·2	10·4	10·5	10·7	10·8	10·9	11·1	11·2	11·4	11·5	11·6	11·8	11·9	12·0	12·2	12·3	12·5
,, 296	9·9	10·0	10·2	10·3	10·5	10·6	10·7	10·9	11·0	11·1	11·3	11·4	11·6	11·7	11·8	11·9	12·1	12·2
,, 300	9·7	9·9	10·0	10·1	10·3	10·4	10·5	10·6	10·8	10·9	11·1	11·2	11·3	11·5	11·6	11·7	11·9	12·0

This condensation, combined with the spray off the flyers, keeps the spinning room floors moist, therefore it is essential that they should be rendered water-tight by being laid with the best English 12in. by 12in. tiles, bedded upon mortar and grouted in with pure liquid cement to prevent the crumbling away of the plaster and joints of the ceiling underneath, which would injure the machinery, possibly endanger life.

Floor of Spinning Rooms.

For health's sake the spinning room floor should be at least four inches higher down the centre than at the sides of the room, and along the sides should run open iron shores having a fall into the waste pipe to carry off all water and filth. This receding of the floor from centre to sides renders the levelling-up of the spinning frames necessary. This is effected in a desirable manner by inserting well-fitted and prepared blocks of pine or Memel timber below the feet. This resinous wood withstands wet for years, especially if set above and below in white or red lead putty, to exclude even moisture. To save time a well-seasoned and painted stock of all sizes of these blocks should be kept on hand. They may range from 2in. to 6in. in height and size to say $\frac{1}{16}$ of an inch. These packings improve the spinning capabilities of the frame, as they act as a sort of buffer or cushion into which all the "jar" of the working parts passes, rendering the running of the frame far more sweet. Cast iron blocks have been tried and are found unsuitable from being so rigid.

Levelling Spinning Frames.

Before we pass entirely from the capabilities of a spinning frame in the matter of "cuts per spindle," it may be well to remark that there is a very speedy and simple contraction of the rather lengthy calculation to find the cuts per spindle from the revolutions of boss or bottom roller. This is :— Multiply the revolutions of the bottom roller per minute by its extreme diameter and divide the result by the number "6·6in. ;" this will give the cuts per spindle per day of nine hours and twenty minutes that should be reeled off that frame. By this rule ample allowance (15 per cent.) is made for all stoppage, contraction by twist and loss.

Calculating the "Cuts per Spindle."

EXAMPLE.

Bottom roller........................... 60 revolutions per minute.
2 inches, extreme diameter.

6·6)120·0

18·2 cuts reeled per day.

PROOF.

Bottom roller........................... 60 revolutions per minute.
6·86 inches, extreme circumference.

411·6 inches delivered per minute.
560 minutes per day.

One yard = inches 36)230496·

One cut = yards 300)6403 yards per day.

21·3 gross cuts.
Less for loss 15 per cent = 3·2 cuts.

18·1 cuts reeled per day.

Here follows a table which will be found to embrace all speeds and sizes of spinning frame, bottom rollers of any pitch.

SPINNING FRAME TURN-OFF TABLE PER 9½ HOURS, 15 PER CENT. INCLUDED FOR STOPPAGE, DOFFING, CONTRACTION BY TWIST, WASTE, ETC.

Roller Dia.	1·25	1·30	1·35	1·40	1·45	1·50	1·55	1·60	1·65	1·70	1·75	1·80	1·85	1·90	1·95	2·00
NEARLY 64ths	16	19	22	25	29	32	35	38	42	45	48	51	54	58	61	64
32nds	8	9	11	13	15	16	18	19	21	22	24	26	27	29	30	32
28ths	7	8	10	11	13	14	15	16	18	19	21	22	24	25	27	28
24ths	6	7	8	10	11	12	13	15	16	17	18	19	21	22	23	24
20ths	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
16ths	4	5	..	..	7	8	9	..	..	11	12	13	..	..	15	16
14ths	..	4	5	6	..	..	8	..	9	10	..	..	12	..	..	14
12ths	3	..	4	5	..	6	..	..	8	..	9	..	..	11	..	12
10ths	..	3	..	4	..	5	..	6	.	7	..	8	..	9	..	10
8ths	2	..	..	..	..	4	..	5	..	...	6	..	..	..	..	8

Roller Dia.	1·25	1·30	1·35	1·40	1·45	1·50	1·55	1·60	1·65	1·70	1·75	1·80	1·85	1·90	1·95	2·00
Revolutions. 20	3·8	3·9	4·1	4·2	4·4	4·5	4·7	4·8	5·0	5·1	5·3	5·5	5·6	5·7	5·9	6·1
21	4·0	4·1	4·3	4·4	4·6	4·8	4·9	5·1	5·2	5·4	5·6	5·7	5·9	6·0	6·2	6·4
22	4·2	4·3	4·5	4·7	4·8	5·0	5·2	5·3	5·5	5·7	5·8	6·0	6·2	6·3	6·5	6·7
23	4·3	4·5	4·7	4·9	5·0	5·2	5·4	5·6	5·7	5·9	6·1	6·3	6·4	6·6	6·8	7·0
24	4·5	4·7	4·9	5·1	5·2	5·4	5·6	5·8	6·0	6·2	6·4	6·5	6·7	6·9	7·1	7·3
25	4·7	4·9	5·1	5·3	5·5	5·7	5·9	6·0	6·2	6·4	6·6	6·8	7·0	7·2	7·4	7·6
26	4·9	5·1	5·3	5·5	5·7	5·9	6·1	6·3	6·5	6·7	6·9	7·1	7·3	7·5	7·7	7·9
27	5·1	5·3	5·5	5·7	5·9	6·1	6·3	6·5	6·7	6·9	7·2	7·4	7·6	7·8	8·0	8·2
28	5·3	5·5	5·7	5·9	6·1	6·4	6·6	6·8	7·0	7·2	7·4	7·6	7·8	8·1	8·3	8·5
29	5·5	5·7	5·9	6·1	6·3	6·6	6·8	7·0	7·2	7·4	7·7	7·9	8·1	8·3	8·5	8·8
30	5·7	5·9	6·1	6·4	6·6	6·8	7·0	7·3	7·5	7·7	7·9	8·2	8·4	8·6	8·8	9·1
31	5·9	6·1	6·3	6·6	6·8	7·0	7·3	7·5	7·7	8·0	8·2	8·4	8·7	8·9	9·1	9·4
32	6·1	6·3	6·5	6·8	7·0	7·3	7·5	7·7	8·0	8·2	8·5	8·7	9·0	9·2	9·4	9·7
33	6·2	6·5	6·7	7·0	7·2	7·5	7·7	8·0	8·2	8·5	8·7	9·0	9·2	9·5	9·7	10·0
34	6·4	6·7	6·9	7·2	7·4	7·7	8·0	8·2	8·5	8·7	9·0	9·3	9·5	9·8	10·0	10·3
35	6·6	6·9	7·1	7·4	7·7	7·9	8·2	8·5	8·8	9·0	9·3	9·5	9·8	10·1	10·3	10·6
36	6·8	7·1	7·3	7·6	7·9	8·2	8·4	8·7	9·0	9·3	9·5	9·8	10·1	10·4	10·6	10·9
37	7·0	7·3	7·5	7·8	8·1	8·4	8·7	9·0	9·2	9·5	9·8	10·1	10·3	10·6	10·9	11·2
38	7·2	7·5	7·8	8·1	8·3	8·6	8·9	9·2	9·5	9·8	10·1	10·4	10·6	10·9	11·2	11·5
39	7·4	7·7	8·0	8·3	8·5	8·8	9·2	9·4	9·7	10·0	10·3	10·6	10·9	11·2	11·5	11·8
40	7·6	7·9	8·2	8·5	8·8	9·1	9·4	9·7	10·0	10·3	10·6	10·9	11·2	11·5	11·8	12·1
41	7·8	8·1	8·4	8·7	9·0	9·3	9·6	9·9	10·2	10·5	10·9	11·2	11·5	11·8	12·1	12·4
42	7·9	8·3	8·6	8·9	9·2	9·5	9·8	10·2	10·5	10·8	11·1	11·4	11·7	12·1	12·4	12·7
43	8·1	8·5	8·8	9·1	9·4	9·8	10·1	10·4	10·7	11·1	11·4	11·7	12·0	12·4	12·7	13·0
44	8·3	8·7	9·0	9·3	9·6	10·0	10·3	10·6	11·0	11·3	11·6	12·0	12·3	12·7	13·0	13·3
45	8·5	8·9	9·2	9·5	9·8	10·2	10·6	10·9	11·2	11·6	11·9	12·3	12·6	13·0	13·2	13·6
46	8·7	9·1	9·4	9·8	10·1	10·4	10·8	11·1	11·5	11·8	12·2	12·5	12·8	13·2	13·5	13·9
47	8·9	9·2	9·6	10·0	10·3	10·7	11·0	11·4	11·7	12·1	12·4	12·8	13·1	13·5	13·8	14·2
48	9·1	9·4	9·8	10·2	10·5	10·9	11·3	11·6	12·0	12·3	12·7	13·1	13·4	13·8	14·1	14·5
49	9·3	9·6	10·0	10·4	10·7	11·1	11·5	11·9	12·2	12·6	13·0	13·4	13·7	14·1	14·4	14·8
50	9·5	9·8	10·2	10·6	10·9	11·3	11·7	12·1	12·5	12·9	13·2	13·6	14·0	14·4	14·7	15·1
51	9·6	10·0	10·4	10·8	11·2	11·6	12·0	12·3	12·7	13·1	13·5	13·9	14·2	14·7	15·0	15·4
52	9·8	10·2	10·6	11·0	11·4	11·8	12·2	12·6	13·0	13·4	13·8	14·2	14·5	15·0	15·3	15·7
53	10·0	10·4	10·8	11·2	11·6	12·0	12·4	12·8	13·2	13·6	14·0	14·5	14·8	15·3	15·6	16·1
54	10·2	10·6	11·0	11·5	11·8	12·3	12·7	13·1	13·5	13·9	14·3	14·7	15·1	15·6	15·9	16·4
55	10·4	10·8	11·2	11·7	12·0	12·5	12·9	13·3	13·7	14·1	14·6	15·0	15·4	15·8	16·2	16·7
56	10·6	11·0	11·4	11·9	12·3	12·7	13·1	13·5	14·0	14·4	14·8	15·3	15·7	16·1	16·5	17·0
57	10·8	11·2	11·6	12·1	12·5	12·9	13·4	13·8	14·2	14·7	15·1	15·5	16·0	16·4	16·8	17·3
58	11·0	11·4	11·8	12·3	12·7	13·2	13·6	14·0	14·5	14·9	15·4	15·8	16·2	16·7	17·1	17·6
59	11·2	11·6	12·0	12·5	12·9	13·4	13·9	14·3	14·7	15·2	15·6	16·1	16·5	17·0	17·4	17·9
60	11·4	11·8	12·2	12·7	13·1	13·6	14·1	14·5	15·0	15·4	15·9	16·4	16·8	17·3	17·7	18·2
61	11·5	12·0	12·4	12·9	13·3	13·8	14·3	14·8	15·2	15·7	16·2	16·6	17·1	17·6	18·0	18·5
62	11·7	12·2	12·6	13·1	13·6	14·1	14·6	15·1	15·5	15·9	16·4	16·9	17·4	17·9	18·3	18·8
63	11·9	12·4	12·9	13·4	13·8	14·3	14·8	15·2	15·7	16·2	16·7	17·2	17·6	18·2	18·6	19·1
64	12·1	12·6	13·1	13·6	14·0	14·5	15·0	15·5	16·0	16·4	17·0	17·4	17·9	18·4	18·9	19·4
65	12·3	12·8	13·3	13·8	14·2	14·8	15·3	15·7	16·2	16·7	17·2	17·7	18·2	18·7	19·2	19·7
66	12·5	13·0	13·5	14·0	14·4	15·0	15·5	16·0	16·5	17·0	17·5	18·0	18·5	19·0	19·4	20·0
67	12·7	13·2	13·7	14·2	14·7	15·2	15·7	16·2	16·7	17·2	17·7	18·3	18·8	19·3	19·7	20·3
68	12·9	13·4	13·9	14·4	14·9	15·4	16·0	16·4	17·0	17·5	18·0	18·5	19·0	19·6	20·0	20·6
69	13·1	13·6	14·1	14·6	15·1	15·7	16·2	16·7	17·2	17·7	18·3	18·8	19·3	19·9	20·3	20·9
70	13·2	13·8	14·3	14·8	15·3	15·9	16·4	16·9	17·5	18·0	18·5	19·1	19·6	20·2	20·6	21·2

SPINNING FRAME TURN-OFF TABLE.—*Continued.*

	Roller Dia.	2·05	2·10	2·15	2·20	2·25	2·30	2·35	2·40	2·45	2·50	2·55	2·60	2·65	2·70	2·75
NEARLY	64ths	3	6	10	13	16	19	22	25	29	32	35	38	42	45	48
	32nds	2	3	5	7	8	9	11	13	15	16	18	19	21	22	24
	28ths	1	3	4	6	7	8	10	11	13	14	15	16	18	19	21
	24ths	1	2	3	5	6	7	8	10	11	12	13	15	16	17	18
	20ths	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	16ths	1	..	..	..	4	5	..	..	7	8	9	..	..	11	12
	14ths	..	..	..	3	..	4	5	6	..	..	8	..	9	10	..
	12ths	..	1	2	..	3	..	4	5	..	6	..	..	8	..	9
	10ths	..	1	..	2	..	3	..	4	..	5	..	6	..	7	..
	8ths	..	..	..	..	2	..	..	..	..	4	..	5	..	..	6

Roller Dia.	2·05	2·10	2·15	2·20	2·25	2·30	2·35	2·40	2·45	2·50	2·55	2·60	2·65	2·70	2·75
Revolutions.															
20	6·2	6·4	6·5	6·7	6·8	7·0	7·1	7·3	7·4	7·6	7·7	7·9	8·0	8·2	8·3
21	6·5	6·7	6·8	7·0	7·1	7·3	7·5	7·6	7·8	7·9	8·1	8·3	8·4	8·6	8·7
22	6·8	7·0	7·2	7·3	7·5	7·7	7·8	8·0	8·2	8·3	8·5	8·7	8·8	9·0	9·2
23	7·1	7·3	7·5	7·7	7·8	8·0	8·2	8·4	8·5	8·7	8·9	9·1	9·2	9·4	9·6
24	7·4	7·6	7·8	8·0	8·2	8·4	8·5	8·7	8·9	9·1	9·3	9·4	9·6	9·8	10·0
25	7·7	7·9	8·1	8·3	8·5	8·7	8·9	9·1	9·3	9·5	9·6	9·8	10·0	10·2	10·4
26	8·1	8·3	8·5	8·7	8·9	9·0	9·2	9·4	9·6	9·8	10·0	10·2	10·4	10·6	10·8
27	8·4	8·6	8·8	9·0	9·2	9·4	9·6	9·8	10·0	10·2	10·4	10·6	10·8	11·0	11·2
28	8·7	8·9	9·1	9·3	9·5	9·7	9·9	10·2	10·4	10·6	10·8	11·0	11·2	11·4	11·7
29	9·0	9·2	9·4	9·7	9·8	10·1	10·3	10·5	10·8	11·0	11·2	11·4	11·6	11·7	12·1
30	9·3	9·5	9·8	10·0	10·2	10·4	10·7	10·9	11·1	11·3	11·6	11·8	12·0	12·3	12·5
31	9·6	9·8	10·1	10·3	10·6	10·8	11·0	11·3	11·5	11·7	12·0	12·2	12·4	12·7	12·9
32	9·9	10·2	10·4	10·7	10·9	11·1	11·4	11·6	11·9	12·1	12·3	12·6	12·8	13·1	13·3
33	10·2	10·5	10·7	11·0	11·2	11·5	11·7	12·0	12·2	12·5	12·7	13·0	13·2	13·5	13·7
34	10·6	10·8	11·1	11·3	11·6	11·8	12·1	12·3	12·6	12·9	13·1	13·4	13·6	13·9	14·2
35	10·9	11·1	11·4	11·7	11·9	12·2	12·5	12·7	13·0	13·2	13·5	13·8	14·0	14·3	14·6
36	11·2	11·4	11·7	12·0	12·3	12·5	12·8	13·1	13·4	13·6	13·9	14·2	14·4	14·7	15·0
37	11·5	11·8	12·0	12·3	12·6	12·9	13·2	13·4	13·7	14·0	14·3	14·6	14·8	15·1	15·4
38	11·8	12·1	12·4	12·7	12·9	13·2	13·5	13·8	14·1	14·4	14·7	15·0	15·2	15·5	15·8
39	12·1	12·4	12·7	13·0	13·3	13·6	13·9	14·2	14·5	14·7	15·1	15·4	15·6	15·9	16·2
40	12·4	12·7	13·0	13·3	13·6	13·9	14·2	14·6	14·8	15·1	15·4	15·7	16·0	16·4	16·7
41	12·7	13·0	13·3	13·6	14·0	14·3	14·6	14·9	15·2	15·5	15·8	16·1	16·4	16·8	17·1
42	13·0	13·4	13·7	14·0	14·3	14·6	14·9	15·2	15·6	15·9	16·2	16·5	16·8	17·2	17·5
43	13·3	13·7	14·0	14·3	14·7	15·0	15·3	15·6	15·9	16·3	16·6	16·9	17·2	17·6	17·9
44	13·7	14·0	14·3	14·6	15·0	15·3	15·7	16·0	16·3	16·6	17·0	17·3	17·6	18·0	18·3
45	14·0	14·3	14·6	15·0	15·3	15·7	16·0	16·3	16·7	17·0	17·4	17·7	18·0	18·4	18·7
46	14·3	14·6	15·0	15·3	15·7	16·0	16·4	16·7	17·1	17·4	17·8	18·1	18·4	18·8	19·2
47	14·6	14·9	15·3	15·6	16·0	16·3	16·7	17·1	17·4	17·8	18·1	18·5	18·8	19·2	19·6
48	14·9	15·3	15·6	16·0	16·4	16·7	17·1	17·4	17·8	18·2	18·5	18·9	19·2	19·6	20·0
49	15·2	15·6	15·9	16·3	16·7	17·1	17·4	17·8	18·1	18·5	18·9	19·3	19·6	20·0	20·4
50	15·5	15·9	16·3	16·6	17·0	17·4	17·8	18·2	18·5	18·9	19·3	19·7	20·1	20·4	20·8
51	15·8	16·2	16·6	17·0	17·4	17·7	18·1	18·5	18·9	19·3	19·7	20·1	20·5	20·9	21·3
52	16·2	16·5	16·9	17·3	17·7	18·1	18·5	18·9	19·3	19·7	20·1	20·5	20·9	21·3	21·7
53	16·5	16·8	17·2	17·6	18·1	18·4	18·9	19·2	19·7	20·0	20·5	20·9	21·2	21·7	22·1
54	16·8	17·2	17·6	18·0	18·4	18·8	19·2	19·6	20·0	20·4	20·8	21·3	21·7	22·1	22·5
55	17·1	17·5	17·9	18·3	18·7	19·1	19·6	20·0	20·4	20·8	21·2	21·7	22·1	22·5	22·9
56	17·4	17·8	18·2	18·6	19·1	19·5	19·9	20·3	20·8	21·2	21·6	22·1	22·5	22·9	23·3
57	17·7	18·1	18·5	19·0	19·4	19·8	20·3	20·7	21·1	21·6	22·0	22·4	22·9	23·3	23·8
58	18·0	18·4	18·9	19·3	19·8	20·2	20·6	21·1	21·5	21·9	22·4	22·8	23·3	23·7	24·2
59	18·3	18·8	19·2	19·6	20·1	20·5	21·0	21·4	21·9	22·3	22·8	23·2	23·7	24·1	24·6
60	18·6	19·1	19·5	20·0	20·4	20·9	21·4	21·8	22·3	22·7	23·2	23·6	24·1	24·5	25·0
61	19·0	19·4	19·8	20·3	20·8	21·2	21·7	22·1	22·6	23·1	23·5	24·0	24·5	24·9	25·4
62	19·3	19·7	20·2	20·7	21·1	21·6	22·1	22·5	23·0	23·4	23·9	24·4	24·9	25·4	25·8
63	19·5	20·0	20·5	21·0	21·5	21·9	22·4	22·9	23·4	23·8	24·3	24·8	25·3	25·7	26·3
64	19·9	20·3	20·8	21·3	21·8	22·3	22·8	23·2	23·7	24·2	24·7	25·2	25·7	26·2	26·7
65	20·2	20·7	21·1	21·7	22·2	22·6	23·1	23·6	24·1	24·6	25·1	25·6	26·1	26·6	27·1
66	20·5	21·0	21·5	22·0	22·5	23·0	23·5	24·0	24·5	25·0	25·5	26·0	26·5	27·0	..
67	20·8	21·3	21·8	22·3	22·8	23·3	23·8	24·3	24·9	25·3	25·9	26·4	26·9	..	..
68	21·1	21·6	22·2	22·7	23·2	23·7	24·2	24·7	25·2	25·7	26·2	26·8	..	..	..
69	21·4	21·9	22·5	23·0	23·5	24·0	24·6	25·1	25·6	26·1	26·6	..	..	..	..
70	21·7	22·3	22·8	23·3	23·9	24·4	24·9	25·4	26·0	26·5	..	..	..	..	..

SPINNING FRAME TURN-OFF TABLE.—*Continued.*

	Roller Dia.	2·80	2·85	2·90	2·35	3·00	3·05	3·10	3·15	3·20	3·25	3·30	3·35	3·40	3·45	3·50
NEARLY	64ths	51	54	58	61	64	3	6	10	13	16	19	22	25	29	32
	32nds	26	27	29	30	32	2	3	5	7	8	9	11	13	15	16
	28ths	22	24	25	27	28	1	3	4	6	7	8	10	11	13	14
	24ths	19	21	22	23	24	1	2	3	5	6	7	8	10	11	12
	20ths	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10
	16ths	13	..	..	15	16	1	..	..	..	4	5	..	..	7	8
	14ths	..	12	..	..	14	..	..	..	3	..	4	5	6	..	..
	12ths	..	..	11	..	12	..	1	2	..	3	..	4	5	..	6
	10ths	8	..	9	..	10	..	1	..	2	..	3	..	4	..	5
	8ths	..	..	..	..	8	..	..	..	..	2	..	..	..	..	4

Roller Dia.	2·80	2·85	2·90	2·95	3·00	3·05	3·10	3·15	3·20	3·25	3·30	3·35	3·40	3·45	3·50
Revolutions.															
20	8·5	8·6	8·8	8·9	9·1	9·2	9·3	9·5	9·7	9·8	10·0	10·1	10·3	10·4	10·6
21	8·9	9·1	9·2	9·4	9·5	9·7	9·8	10·0	10·2	10·3	10·5	10·6	10·8	11·0	11·1
22	9·3	9·5	9·7	9·8	10·0	10·2	10·3	10·5	10·7	10·8	11·0	11·2	11·3	11·5	11·7
23	9·7	9·9	10·1	10·3	10·4	10·6	10·7	11·0	11·1	11·3	11·5	11·7	11·8	12·0	12·2
24	10·2	10·4	10·5	10·7	10·9	11·1	11·2	11·4	11·6	11·8	12·0	12·2	12·4	12·5	12·7
25	10·6	10·8	11·0	11·2	11·4	11·5	11·7	11·9	12·1	12·3	12·5	12·7	12·9	13·1	13·2
26	11·0	11·2	11·4	11·6	11·8	12·0	12·2	12·4	12·6	12·8	13·0	13·2	13·4	13·6	13·8
27	11·4	11·7	11·9	12·1	12·3	12·5	12·6	12·9	13·1	13·3	13·5	13·7	13·9	14·1	14·3
28	11·9	12·1	12·3	12·5	12·7	12·9	13·1	13·4	13·6	13·8	14·0	14·2	14·4	14·6	14·8
29	12·3	12·5	12·7	13·0	13·2	13·4	13·6	13·8	14·1	14·3	14 5	14·7	14·9	15·1	15·4
30	12·7	12·9	13·2	13·4	13·6	13·9	14·0	14·3	14·5	14·8	15·0	15·2	15·4	15·7	15·9
31	13·1	13·4	13·6	13·8	14·1	14·3	14·5	14·8	15·0	15·3	15·5	15·7	16·0	16·2	16·4
32	13·6	13·8	14·0	14·3	14·5	14·7	15·0	15·3	15·5	15·7	16·0	16·2	16·5	16·7	17·0
33	14·0	14·2	14·5	14·7	15·0	15·2	15·4	15·7	16·0	16·2	16·5	16·7	17·0	17·2	17·5
34	14·4	14·7	14·9	15·2	15·4	15·7	15·9	16·2	16·5	16·7	17·0	17·2	17·5	17·8	18·0
35	14·8	15,1	15·4	15·6	15·9	16·2	16·4	16·7	17·0	17·2	17·5	17·7	18·0	18·3	18·6
36	15·3	15·5	15·8	16·1	16·3	16·6	16·8	17·2	17·4	17·7	18·0	18·3	18·5	18·8	19·1
37	15·7	16·0	16·2	16·5	16·8	17·1	17·3	17·6	18·0	18·2	18·5	18·8	19·0	19·3	19·6
38	16·1	16·4	16·7	17·0	17·3	17·5	17·8	18·1	18·4	18·7	19·0	19·3	19·6	19·8	20·1
39	16·5	16·8	17·1	17·4	17·7	18·0	18·3	18·6	18·9	19·2	19·5	19·8	20·1	20·4	20·7
40	17·0	17·3	17·6	17·9	18·2	18·5	18·7	19·1	19·4	19·7	20·0	20·3	20·6	20·9	21·2
41	17·4	17·7	18·0	18·3	18·6	18·9	19·2	19·6	19·9	20·2	20·5	20·8	21·1	21·4	21·7
42	17·8	18·1	18·4	18·8	19·1	19·4	19·7	20·0	20·4	20·7	21·0	21·3	21·6	21·9	22·3
43	18·2	18 6	18·9	19·2	19·5	19·9	20·1	20·5	20·8	21·2	21·5	21·8	22·1	22·5	22·8
44	18·7	19·0	19·3	19·7	20·0	20·3	20·6	21·0	21·3	21·6	22·0	22·3	22·7	23·0	23·3
45	19·1	19·4	19·9	20·1	20·4	20·8	21·1	21·5	21·8	22·1	22·5	22·8	23·2	23·5	23·8
46	19·5	19·9	20·2	20·6	20·9	21·2	21·5	21·9	22·3	22·6	23·0	23·3	23·7	24·0	24·4
47	19·9	20·3	20·6	21·0	21·3	21·7	22·0	22·4	22·8	23·1	23·5	23·8	24·2	24·5	24·9
48	20·3	20·7	21·1	21·4	21·8	22·2	22·5	22·9	23·3	23·6	24·0	24·3	24·7	25·1	25·4
49	20·8	21·2	21·5	21·9	22·2	22·6	22·9	23·4	23·8	24·1	24·5	24·8	25·2	25·6	26·0
50	21·3	21·6	21·9	22·3	22·7	23·1	23·4	23·8	24·2	24·6	25·0	25·4	25·7	26·1	26·5
51	21·6	22·0	22·4	22·8	23·2	23·6	23·9	24·3	24·7	25·1	25·5	25·9	26·3	26·6	..
52	22·0	22·5	22·8	23·2	23·6	24·0	24·3	24·8	25·2	25·6	26·0	26·4	26 8	..	..
53	22·5	22·9	23·3	23·7	24·1	24·5	24·8	25·3	25·7	26·1	26·5	26·9	..	..	..
54	22·9	23·3	23·7	24·1	24·4	24·9	25·3	25·8	26·2	26·6	27·0	..	..	..	..
55	23·3	23·7	24·1	24·6	25·0	25·4	25·8	26·2	26·7	27·1	..	..	..	..	..
56	23·7	24·2	24·6	25·0	25·4	25·8	26·3	26·7	27·1	..	..	..	..	..	..
57	24·2	24·6	25·0	25·5	25·9	26·3	26 8	27·2	..	..	..	..	..	..	..
58	24·6	25·0	25·5	25·9	26·3	26·8	27·2	..	..	..	..	..	..	..	..
59	25·0	25·5	25·9	26·4	26·8	27·2	..	..	..	..	..	..	..	..	..
60	25·4	25·9	26·3	26·8	27·3	..	..	..	..	..	..	..	..	..	..
61	25·9	26·3	26·8	27·3	..	..	..	..	..	..	..	..	..	..	..
62	26·3	26·8	27·2	..	..	..	..	..	..	..	..	..	..	..	..
63	26·7	27·2	..	..	..	..	..	..	..	..	..	..	..	..	..
64	27·1	..	..	..	..	..	..	..	..	..	..	..	..	..	..
65	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
66	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
67	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
68	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
69	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
70	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

If a frame does not reel the yarn indicated by this table, it may be taken for granted that there is something wrong. Either there is an undue proportion of bands or flyers off and rollers "out," or else the spinner or reeler is making an undue amount of waste; or the spinning frame may not be kept working as it should. Doffers having too little to do, and so delaying too long over each frame, or not keeping the frames properly doffed, may be another cause for the deficiency of yarn.

"Changes" in Spinning.

Before concluding our remarks upon spinning, we should like to impress upon those in authority in the spinning department, the absolute necessity for system in the carrying out of "changes," so as to insure both expedition and accuracy.

In order to accomplish this, there should always be carried about the person, during working hours, a book of changes, arranged in the following order: Copy into the first page the "Table of Twists;" into the second the "Range of Reaches," and the "Drafting Multiplicand" for this range; into the third the "Draft Table" suitable for ditto. On the fourth and following pages allocate a line to each spinning frame there may be in the establishment; close up to the "No. of Frame," on each of these lines, should be columns for the "Pitch of Frame," "Drum Diameter," "Cylinder and Wharve Constant No." "Draft Constant No." "Twist Constant No." Having this portion of the book so arranged, permits of changes being effected without the delay of consulting the list of "Full Particulars" of each frame, which must be entered further on; and it is from the information here derived, that a decision is come to as to the suitability of each particular frame for spinning a new count of yarn. It also becomes a standing list of the sorts spun on each frame, for some time past. The fourth and succeeding pages show thus—

No. of Frame.	Pitch of Frame.	Diameter of Drum.	Constant No. Cylinder & Wharve.	Constant No. Draft.	Constant No. Twist.	Being Spun.
	inch.	inch.				
1	$2\frac{1}{2}$	36	8·5	600	400	40's Warp, 35's Weft, 55's Medium.
2	$2\frac{1}{2}$	36	8·5	600	400	35's Weft, 60's Warp.
3	$2\frac{1}{2}$	36	8·5	600	400	55's Medium.
4	$2\frac{1}{2}$	36	8·5	600	400	45'sW. 65's B. 50'sY. 40'sW. 55'sY.
5	$2\frac{1}{2}$	36	8·5	600	400	60's B. 50'sY. 55'sY. 60's B.
6	$2\frac{1}{4}$	36	8·3	550	700	70's B. 65'sW. 85'sW.
7	$2\frac{1}{4}$	36	8·3	550	700	65'sB. 75'sW. 70'sW. 60'sB. 85'sW. 70'sY. 65'sY. 75'sB.
8	$2\frac{1}{4}$	36	8·3	550	700	75's B. 65'sY.
9	$2\frac{1}{4}$	36	8·3	550	700	80'sW.
10	2	38	8·2	800	600	100'sB 90'sW 85'sW 120'sB 95'sW 80'sW 110'sB 110'sY.
11	2	38	8·2	800	600	120's B. 130's B. 90'sW. 85'sW.
12	etc.	etc.	etc.	etc.	etc.	Etc.
13						

Now, it will be seen that with the "sorts" here enumerated under the heading "Being Spun" taken in conjunction with the revolutions per minute of the driving shaft and the information to be derived from pages 1, 2, and 3, the most desirable frame for spinning any required count of yarn can at once be fixed upon. The change must then be marked down outside the previous one opposite the same frame number on this list; and the calculations are soon made out. Of course all establishments make use of private marks or numbers to distinguish the different qualities of yarn spun, so that really no more space is occupied with the notifying of each change, than is shown opposite frames 4 to 11 on the above extract. In many instances it is therefore quite possible to tell at a glance every sort of yarn that has been spun over any frame for years past.

This information sometimes becomes very valuable, as certain frames, from various causes, such as plenty of speed or the contrary; broad or narrow brass-roller face; high or low creels; single or double axles; extent of range of wheels, pinions and reach; being with or without roller washing appliances; and general good or bad condition, etc., etc., may be most suitable for the spinning of the class of yarn required. This particular yarn may not have been spun for a long time previously, and (only for the "change book") some peculiar requirement necessary to its production, might have been long since forgotten, until brought to remembrance by some unforeseen difficulty arising at a very unseasonable juncture.

"Change Book." Another matter of consequence is to apportion off part of the other side of the same book for the entering down of the particulars of each change as it is made. This entry to go under the heading of "Changes in Spinning," and to be composed of a column for the number of the frame that is changed; one for the sort changed to; one for the yards per ounce of rove; one for the spinning draft for that lea; one for the reach for same; one for the cuts per spindle for ditto; one for the pulley diameter; one for the twist wheel; and, lastly, one for the date of change and for remarks, thus:—

CHANGES IN SPINNING.

No. of Frame.	Changed to	Yards per Ounce Rove.	Draft.	Reach.	Cuts.	Pulley Diameter	Draft Pinions.	Twist Wheel.	Date.	Remarks.
60	70's warp	140	9·7	$2\frac{3}{8}''$	14	15″	69	60	18/2/78	
3	80's weft	160	9·7	$2\frac{1}{4}''$	12	14″	75	56	19/2/78	Spin 60 reels.
70	30's medium	70	8·1	$3\frac{1}{8}''$	19	18″	40	45	19/2/78	Spin 200 bundles.
71	60's prime	120	9·7	$2\frac{5}{8}''$	$13\frac{1}{2}$	16″	50	55	19/2/78	
73	45's super	120	7·3	$2\frac{7}{8}''$	15	15″	67	64	21/2/78	Yellow leasing.
74	45's super	120	7·3	$2\frac{7}{8}''$	15	15″	67	64	21/2/78	do.
55	45's super	120	7·3	$2\frac{7}{8}''$	15	17″	59	50	21/2/78	do.
80	30's weft	70	8·1	$2\frac{7}{8}''$	$16\frac{1}{2}$	20″	50	44	21/2/78	
104	160's warp	300	10·7	$1\frac{3}{4}''$	9	12″	76	76	25/2/78	
12	20's tow warp	50	7·6	$3\frac{1}{8}''$	21	17″	43	50	3/3/78	

It will be remarked that each frame is entered separately, even though many frames of the same class are on the same sort of work. This is advisable, as, from ever so slight a difference in the size of the roller or in the size of some of the pinions, it may require a tooth more or less to bring the yarn to the same weight on that frame as it is on the others.

The particulars being thus accurately kept, and a suitable weight for each kind of rove arrived at, and the rove kept steady to that weight, in the course of time many changes can be made without any calculation whatever, simply by referring back to the entry made on a previous occasion when the same class of yarn was spun over the same frame. Of course the repairing of frames will alter these notes, but frames are not repaired with such frequency as to give much trouble on this score. Referring to the repairing of frames calls to mind the importance of having always to hand a small note book, in which to jot down trifling affairs that require notice; as in a spinning mill there is such a never-ending run of small matters to attend to, as to preclude the possibility of even the most clear-headed remembering them all. Nothing tends to worry one more than the being always in doubt as to whether something that should at once be attended to may not have been forgotten. Among other things, those interested should systematically jot down the alterations effected on each frame by repairs. This is best to be done just when the frame is being got ready for a start, and then during the first leisure moments these particulars can be entered in their proper place, and the new "constant numbers" made out. No doubts or mistakes can arise if this system be adopted and carried out.

Repairs to Spinning Frame Notes.

"Change."

With regard to spinning, the term "change" means the taking out of the rove in the creel at the time, and the putting in some other rove specified, together with all the attending alterations. "Turn" means leaving the rove in the creel and drafting it to the required lea; this being notified, to save mistakes and mixing of rove, by always allowing the original term by which the rove was called to remain, and underneath notifying the name and lea of the yarn being spun out of it.

"Turn."

A frame of 70's warp rove spinning down to 40's super will thus be notified on the end of the spinning frame creel—

70's warp.
40's super, etc.

Then if it be required to turn the 40's super yarn to 100's weft, it must not be notified 40's turned to 100's, but 70's to 100's, thus:—

70's warp.
100's weft.

These terms being understood, we give the printed form, and fill in (*in italics*) to illustrate the two different orders of "to turn" and "to change." Those who are responsible for the changing of the frames, on receipt of the order forms should carefully file them, so that if the manager be suspicious of drafts being surreptitiously shortened to improve the spin, or of the twist being slackened out to increase turn-off (as is very often practised when the wheels and pinions are kept in the room, and when a bonus of, say, 1d. per reel is given on every reel produced in excess of a standard quantity), his suspicions may be set at rest, when he compares the wheels ordered with those on the frame, and finds them to correspond. It is to enable the manager to check the wheels of certain frames occasionally, and so satisfy himself of their accuracy, that it is desirable for him to copy the particulars of each change into his pocket-book.

SPINNING ORDER FORMS.

As 50's line warp rove runs out,
Change frames Nos. *7, 10, and 25* to *80's line weft.*
Out of *60's line medium* rove, off *one half of* roving frame No. *9.*
Room No. *3*

Reach	$2\frac{1}{8}''$
Pulleys	16"
Cuts	12
Twist wheel	21
Draft pinions	67

REMARKS.

Clean troughs, change rollers.
Gray leasing *19/6/78*

....
Turn frames No. *7, 10, and 25* to *60's line medium.*
Out of .... rove, off..........
roving frame No. ..
Room No. ..

Reach	——
Pulleys	13"
Cuts	16
Twist wheel	23
Draft pinions	86

REMARKS.

Spin 50 reels *4/8/78*

Bonus on Production. Where the changes are not looked after as carefully as here recommended, it is a mistake to pay a bonus on over-production for the reasons above mentioned; and also on account of the certainty of increased waste, impoverishing of material, increased wear and tear of machinery, increase in the quantity of mill furnishings required, and last, but by no means most insignificant factor in the argument against the bonus system, increased unsteadiness and discontent produced amongst the operatives on account of their feeling themselves to be unduly pressed, solely for the aggrandisement of those in authority over them. But, when the frames can only be driven at stated speeds, it is all gain to grant this bonus, as it is surprising how much yarn can be gained or lost by the sharp starting and stopping of the spinning frames, speedy doffing, and steady class of workers, or the reverse.

Pinion Store. Where possible, there should be a store for all pulleys, wheels, and pinions, except those actually in work. If there be room they and other necessaries, such as belting, banding, leasing, brushes, whiting, chalk, knives, pickers, rubber, flannel, soap, etc., might be kept in the bobbin store, and be all under the supervision of one responsible man, whose duty would consist in exchanging articles required for those not needed or worn out. If wheels and pinions be assorted according to their pitch and bore, and, thus assorted, be placed either on iron pins driven into the wall, or in compartments fitted up for their reception, there will not be the least difficulty in at once alighting upon the wheel or pinion required, if such be about the establishment. Drums and pulleys should be reared in separate piles, according to their bore, on the floor, having stout iron rods run through their centres, to prevent them toppling over.

Gateman. If the concern be small, say of 5,000 to 9,000 spindles, one man should be fully capable of taking charge of this general mill furnishing store, of looking after the gate, of weighing the coals, and of measuring and mixing the oils; but if it be large, say up to 30,000 spindles, the charge will certainly have to be divided. This is easily arranged by appointing a gateman, who in his spare time will attend to the weighing of the coal, the counting of yarn and such like matters that can be looked after intermittently.

Particulars of Spinning Frames. We here append full particulars of each class, or pitch, of wet spinning frame; suitable for spinning the whole range of yarn from 8's to 350's lea. The length of the blade, and the over-all length of the spindles is to the top of the screw. The extra particulars noted at the bottom of this list, but not specified, are essential to the head-spinner or to the manager, to particularise those frames with which he has to deal, but are foreign to the list now under consideration.

FULL PARTICULARS OF SIX DIFFERENT SPINNING FRAMES.

Pitch of frame	3in.	$2\frac{3}{4}$in.	$2\frac{1}{2}$in.	$2\frac{1}{4}$in.	2in.	$1\frac{3}{4}$in.
Top roller flutes per inch	16	20	24	30	32	36
Top roller, breadth of face	$1\frac{1}{8}$in.	1in.	$\frac{13}{16}$in.	$\frac{3}{4}$in.	$\frac{11}{16}$in.	$\frac{5}{8}$in.
Top roller, extreme diameter	2in.	$1\frac{3}{4}$in.	$1\frac{1}{2}$in.	$1\frac{1}{4}$in.	$1\frac{1}{4}$in.	1in.
Bottom roller flutes per inch	20	24	30	32	36	40
Bottom roller, breadth of face	$\frac{15}{16}$in.	$\frac{13}{16}$in.	$\frac{11}{16}$in.	$\frac{5}{8}$in.	$\frac{1}{2}$in.	$\frac{7}{16}$in.
Bottom roller, extreme diameter	$3\frac{3}{4}$in.	$3\frac{1}{4}$in.	$2\frac{3}{4}$in.	$2\frac{1}{4}$in.	$1\frac{3}{4}$in.	$1\frac{1}{4}$in.
Cylinder diameter	13in.	12in.	11in.	10in.	9in.	8in.
Wharve diameter	$1\frac{1}{2}$in.	$1\frac{4}{16}$in.	$1\frac{3}{16}$in.	$1\frac{2}{16}$in.	$1\frac{1}{16}$in.	$\frac{9}{16}$in.
Blade diameter	$\frac{7}{16}$in.	$\frac{5}{32}$in.	$\frac{4}{16}$in.	$\frac{4}{32}$in.	$\frac{3}{16}$in.	$\frac{7}{32}$in.
Blade (including spindle top) length	8in.	$7\frac{1}{4}$in.	$6\frac{1}{2}$in.	6in.	$5\frac{1}{4}$in.	$4\frac{5}{8}$in.
Neck diameter	$\frac{7}{32}$in.	$\frac{1}{2}$in.	$\frac{7}{16}$in.	$\frac{4}{16}$in.	$\frac{3}{8}$in.	$\frac{3}{16}$in.
Neck length	$3\frac{3}{4}$in.	$3\frac{1}{2}$in.	$3\frac{1}{4}$in.	$2\frac{3}{4}$in.	$2\frac{1}{2}$in.	$2\frac{1}{4}$in.
Butt (including spindle foot) length	$11\frac{3}{4}$in.	$10\frac{3}{4}$in.	$9\frac{3}{4}$in.	$8\frac{3}{4}$in.	$7\frac{3}{4}$in.	$6\frac{5}{8}$in.
Butt diameter	$\frac{7}{16}$in.	$\frac{5}{8}$in.	$\frac{7}{32}$in.	$\frac{9}{16}$in.	$\frac{1}{2}$in.	$\frac{5}{32}$in.
Overall length of spindle	$23\frac{1}{2}$in.	$21\frac{1}{2}$in.	$19\frac{1}{2}$in.	$17\frac{1}{2}$in.	$15\frac{1}{2}$in.	$13\frac{1}{2}$in.
Spindle foot diameter	$\frac{7}{16}$in.	$\frac{5}{32}$in.	$\frac{4}{16}$in.	$\frac{4}{32}$in.	$\frac{3}{16}$in.	$\frac{7}{32}$in.
Length from bottom roller nip to flyer eye	$11\frac{3}{4}$in.	$10\frac{3}{4}$in.	$9\frac{3}{4}$in.	$8\frac{3}{4}$in.	$7\frac{3}{4}$in.	$6\frac{3}{4}$in.
Internal size of warp flyer	$2\frac{1}{8} \times 3\frac{1}{8}$in.	$1\frac{7}{8}$in. $\times$ $2\frac{7}{8}$in.	$1\frac{5}{8} \times 2\frac{1}{2}$in.	$1\frac{3}{8} \times 2\frac{1}{4}$in.	$1\frac{1}{8}$in. $\times$ 2in.	$\frac{13}{16}$in. $\times$ $1\frac{1}{16}$in.
Internal size of weft flyer	$1\frac{3}{4}$in. $\times$ $3\frac{3}{8}$in.	$1\frac{5}{8}$in. $\times$ $3\frac{1}{16}$in.	$1\frac{3}{8} \times 2\frac{3}{4}$in.	$1\frac{3}{16}$in. $\times$ $2\frac{1}{2}$in.	$\frac{13}{16}$in. $\times$ $2\frac{3}{16}$in.	$\frac{5}{8}$in. $\times$ $1\frac{7}{8}$in.
Warp bobbin head diameter	$1\frac{5}{8}$in.	$1\frac{7}{16}$in.	$1\frac{1}{4}$in.	$1\frac{1}{8}$in.	$\frac{7}{8}$in.	$1\frac{1}{16}$in.
Weft bobbin head diameter	$1\frac{3}{8}$in.	$1\frac{3}{16}$in.	$1\frac{1}{16}$in.	$\frac{15}{16}$in.	$\frac{3}{4}$in. $\times$ $\frac{9}{16}$in.	$\frac{7}{16}$in.
Average weight of drag weight	20oz.	15oz.	10oz.	6oz.	3oz.	$\frac{3}{4}$oz.
Average breadth of builder	$6\frac{1}{2}$in.	6in.	$5\frac{1}{2}$in.	5in.	$4\frac{1}{2}$in.	4in.
Warp traverse	$2\frac{3}{4}$in.	$2\frac{1}{2}$in.	$2\frac{1}{4}$in.	2in.	$1\frac{3}{4}$in.	$1\frac{1}{2}$in.
Weft traverse	3in.	$2\frac{3}{4}$in.	$2\frac{1}{2}$in.	$2\frac{1}{4}$in.	2in.	$1\frac{3}{4}$in.
Range of reach	5in. to $3\frac{1}{2}$in.	$4\frac{1}{4}$in. to $2\frac{3}{4}$in.	$3\frac{1}{2}$in. to $2\frac{1}{2}$in.	3in. to 2in.	$2\frac{1}{2}$in. to $1\frac{3}{4}$.	2in. to $1\frac{1}{4}$in.
Range of warp lea	10's to 18's	20's to 35's	40's to 60's	65's to 85's	90's to 150's	160's up.
Range of weft lea	8's to 14's	16's to 25's	30's to 50's	50's to 75's	80's to 120's and 130's to 170's	180's up.
Net weight of spindle, empty bobbin, and flyer	2lb. 4oz.	1lb. $11\frac{1}{2}$oz.	1lb. $5\frac{1}{2}$oz.	1lb. $1\frac{1}{2}$oz.	0lb. 12oz.	0lb. $6\frac{3}{4}$oz.
Wire gauge for flyer eye	14's	15's	16's	17's	18's	19's
No. of frame	....	....	....	....	....	....
Maker's name	....	....	....	....	....	....
Diameter of drum	....	....	....	....	....	....
Diameter of pulley	....	....	....	....	....	....
Diameter of pulley bore	....	....	....	....	....	....
No. of spindles in frame	....	....	....	....	....	....
Stud wheel teeth	....	....	....	....	....	....
Top roller wheel teeth	....	....	....	....	....	....
Bottom roller pinion	....	....	....	....	....	....
Constant No. for draft	....	....	....	....	....	....
Pitch of draft gearing	....	....	....	....	....	....
Bore of change or draft pinion	....	....	....	....	....	....
Cylinder pinion	....	....	....	....	....	....
Bottom roller circumference	....	....	....	....	....	....
Bottom roller wheel	....	....	....	....	....	....
Crown wheel	....	....	....	....	....	....
Constant No. for twist	....	....	....	....	....	....
Pitch of twist gearing	....	....	....	....	....	....
Bore of twist wheel	....	....	....	....	....	....

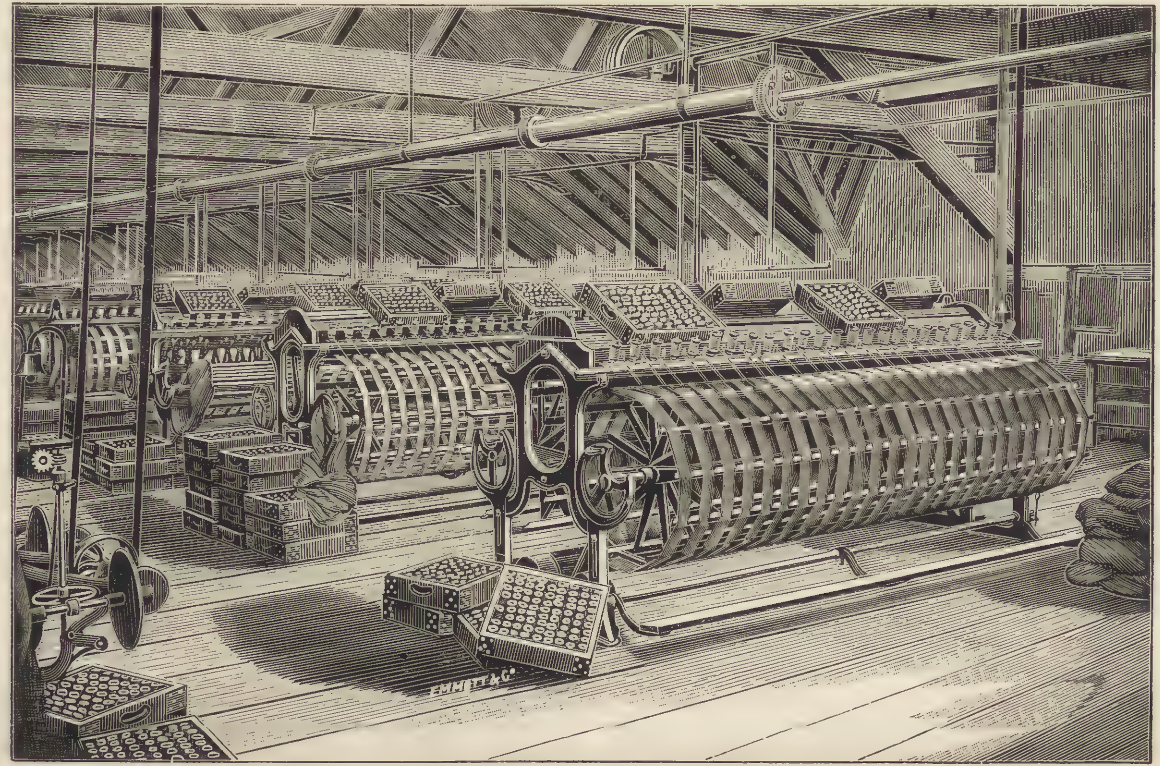
We will conclude our remarks upon spinning by giving an average wages list, of the female operatives employed in the spinning department. These rates are for full time per week otherwise they lose one penny per diem, exclusive of the deduction made for the time they have absented themselves.

Spinners' Wages.

	1855.	1865.	1875.	1884.	
	D.	D.	D.	D.	
Spinners (two sides)	12	16	16½	16	Per day.
Spinners (one side)	9	15	15½	15	
Piecers	9	12	15½	15	
Layers	7½	11	14½	14	
Doffers	6½	8	12	11	

PART V.

YARN DEPARTMENT.



REELING ROOM.

CHAPTER XIX.

ON REELING.

THE reeling or measuring of the yarn off the spinning bobbins on to reels is a very simple but all-important branch of flax and tow spinning; in fact, so important is it that the reelers—that is the women who manipulate the reels—can, if they combine, stop any spinning concern in about three hours.

Reeling.

The reason of this is that in no mill is there an indefinite number of spinning bobbins always to hand that could be filled, and so keep the frames spinning. One bobbin does not hold very much (from one to three cuts), and it is not very hard to calculate how many of these bobbins would be required in a concern which can produce from 200,000 to 400,000 cuts of yarn daily. But even supposing that it were possible to keep the frames going, it would be very injudicious to do so when the yarn was not being reeled off, as if it be permitted to remain too long on the bobbin it will blue-mould, and soon decay, unless prompt means be taken for drying it. We have known of over two hundred bundles of yarn on bobbins, of the value of say £60, having to be thrown to the fires in a single day; this being due to a reelers' strike for higher wages having occurred in the establishment at an hour's notice, thus paralysing the efforts of the manager to save the yarn still on bobbins. Again, even supposing that there was unlimited means, both for supplying bobbins and for drying the yarn on these bobbins, there would not be sufficient cages to meet the emergency.

Cages.

Cages are boxes of light, handy build, made either of wood, wood and iron, or tin, filled with strong iron pins, rising the same height out of the bottom of the cage as the length of the bobbin that is to be placed on it. There must be six cages allocated to each spinning frame, to be stamped with the number of that frame, and on no consideration to be used in connection with any other. Each cage must contain exactly the same number of pins as there are spindles in the side of the frame. To have two cages for each doff is advantageous—they are more easily hawked by both carrier and reeler, one in each hand. With this arrangement, also, each spinner's work can be kept entirely distinct, thus rendering the detection of the author of any fault in the yarn less difficult. But where the bobbins become small, say off 2in. pitch frames, spinning from 100's lea up, one cage of moderate dimensions can easily contain the whole doff, in which case there should be exactly the same number of pins in cage as there are spindles in frame, and three cages will be found amply sufficient for each frame, one for the doff being spun, one for the doff spun, and one for the doff being reeled.

When the bobbins on the spinning frame are full of yarn, the doffers take them off and place them in their boxes, which are then carried by young learners, called "cagers," to the cage, and caged, it being the duty of the doffing mistress to see that the pins are covered, even though some should be covered with empty bobbins only. This system ensures against either loss of yarn or breakage of bobbins.

Yarn-Hawking.

The yarn hawker next comes round with his light cart, and places these cages with others already on it. The number of the frame being stamped legibly on the cage is security against any mixture.

The cart is then run into a lift or hoist large enough to contain it and the man who has charge of it and the hoist man (a hoist will soon pay for itself, even in the smallest concern), and it is then lifted to the lobby communicating with the reeling room. The hawker has then to put down the cages beside the reels that have the same numbers as those stamped on them; and when all are thus distributed he takes up the empty doff of bobbins from each as they are ready and returns to the spinning room, leaving the empty bobbins under their own frames.

This system of yarn hawking leaves the hawker alone accountable for lost or mixed bobbins. He need not take away the full doffs without satisfying himself that every pin is covered, and no reeler need receive the doffs from him unless they be complete. She well knows that he will not receive them back from her unless there be the full complement of bobbins, as he is answerable to the doffing mistress for delivering to her the full number. In this way not a single bobbin need be declared lost, stolen, or strayed, without the reeling or spinning master becoming fully cognisant of the whole particulars, and replacing them that may be wanting at discretion.

No set number of frames can be specified as being fair work for the yarn hawker, so much depends upon the average lea of the yarn, and the distance of the reeling-room from the spinning-room. The number may range from the spinning of six frames to be carried by hand, to that of sixty frames to be carried on cart. But his work can be materially expedited by those in authority keeping the hoist and floors in good condition, the latter depending much upon the style of hand-cart in use, particularly the size and make of the wheels.

Carts. The wheels of the yarn cart, as also of the rove and roller carts, should be of either wood or leather—if of wood, the socket of wheel driven into disused preparing roller bosses will last fairly well, but the increased wearing power of slabs of well-seasoned beech cut with the grain, and three or more slabs of the same laid transversly one on the other, and firmly bolted together, and after this turned up in the lathe, will more than counterbalance the extra cost of their make. If of leather, a sufficient number of layers of 4in. or 5in. old leather belting, laid flat between two flanges of iron a little smaller, and these very firmly screwed together with four or six strong screws, will make a wheel which, when turned up so as to leave the leather ring rising at least one quarter of an inch above the edge of the iron flanges, will be very durable, and at the same time cheap, as they can be refilled at any time with the valueless cuttings of old belting. Cuttings of 3in. belting will be sufficiently large for the fore and aft wheels of the cart, which require to be about an inch smaller in diameter than the side wheels, as they work on swivels, and simply act as guides for turning, the cart running much lighter when balanced on the two side wheels only.

The mention of guide wheels reminds us that it is in this manner that the friction pulleys for the power reels are made, with this difference, that usually new leather washers are put into them, whereas the old belting will do very nearly as well, and does not cost a tithe of what the washers cost.

Hitherto, in the generality of manufactories the reels have been driven by the hand, as they are so light and require to be so incessantly stopped as to render the application of steam power nearly valueless. But

Power Reels. of late reelers have become so scarce that the loss in the turn-off resulting from this cause has compelled employers to consider some method of enticing more learners to this branch of manufacture. The reeler's pay is sufficiently good, but so is her work certainly sufficiently hard and incessant to make it no sinecure. Employers are, therefore, now going to the immense and continuous expense of putting in reels that may

be driven by steam power so as to lessen the manual labour of the reeler, hoping by this means to draw into their employment those who do not relish the idea of the more laborious hand reeling. This is the only benefit derived from steam reeling, and to secure which the outlay is large. For example, over and above the requirements of the hand reel there has to be shafting and gearing, belting, etc.

The construction of the steam power-reel, roughly described, is as follows: There is a small countershaft on the end of each reel, to which friction pulleys are keyed. When it is desired to make the "fly" of the reel revolve, a friction plate, feather keyed to the end of the axle, is pressed against the revolving friction pulley. This pressure is communicated from the woman's foot to the friction plate by means of a simple lever and crank connection between a foot-board underneath the fly, and a small runner facing up against the side of the friction plate, reverse to that against which works the friction pulley. The lifting of the foot off the board takes the pressure off the friction plate, which, by means of a spring, then recedes from the friction pulley, thus stopping the fly.

The newest and best power reel of the day is turned out by a firm of machinists at Belfast. They have introduced on it their simple but very ingenious patent for stripping the yarn off the fly without the possibility of its coming in contact with any oil or grease that is of necessity about the axle of the fly, and which heretofore has been a source of much staining of yarn.

The construction of this patent yarn stripper is as follows: The end of axle of fly reverse from the friction end is contained in a socket. This socket is enlarged in disc form to about the shape of a three-quarter moon. This disc is supported in a grooved circle bolted to the gable of the reel. There is a sufficient opening in the top of the circle to allow a good-sized body to drop into the hollow in the disc, on the latter being turned round in the circle with a handle, so as to receive it. Formerly, to get the yarn off the reel, the end of the axle had to be lifted off its seat and the yarn slipped over. With this arrangement the yarn is dropped into the hollow in the disc, which is then turned round in the grooved circle once. This carries round the yarn, contained in the hollow of the disc, to the opening in the circular bracket, from which it now comes away, quite clear of the axle of the fly. The nicety of this arrangement consists in an endless ring of yarn being stripped off an axle, the end of which is confined in the gable of the reel, and that without coming near to the oily axle.

Yarn Measurement.

The measuring of the yarn is accomplished in this manner. On the axle of the fly, at the side opposite to that on which the yarn is stripped off, is a worm or small spiral screw wheel, which is in gear with a wheel called the bell wheel. One revolution of the fly causes the worm wheel to turn the bell wheel one tooth, and as there are 90in. in circumference of the fly, and 120 teeth in the bell wheel, it is plain that for every 300 yards of yarn reeled the bell wheel makes one revolution. On completing this revolution a catch on the axle of the bell wheel comes in contact with an upright spring, to which is attached a bell, and the reaction of the spring causes the bell to ring. This denotes that the 300 yards have been reeled, and thus we have a cut of yarn.

Cut of Yarn.

On the first cut being reeled, a piece of thread, called leasing, is tied round it, and the ends are left in such a position as to be easily lapped round each successive cut, thus effectually separating one from the other until the twelfth cut is reeled, when the reeler ties it up securely in the leasing, and trims off the surplus ends of leasing.

Hank of Yarn

Having arrived at this point, the reeler strips the various bands of yarn of the length of $300 \times 12 = 3{,}600$ yards each,

called hanks, off her reel. The hanks of yarn are slackened on the fly by different methods, to admit of their being slipped along it and stripped off. The older method is for the reeler to withdraw wooden pins from the spokes of a particular rail of the fly. This permits this rail to drop down as its spokes shoot through slots cut in the axle. The reduction in the circumference of the fly caused by the absence of this rail, leaves the yarn slack on the fly. From the wearing away of these wooden pins and the parts against which they bear, the rail soon ceases to face up to the true circle of the fly, thus causing the yarn to be of short measure. As an improvement, it is now customary to have all the spokes, except the two outside ones and the centre one, slack on the axle of the fly. These three are jointed (about four inches below their rail) with a semicircular or rule-joint, which allows of the rail being drawn out of position on the unhooking of a band that passes from it round the under side of the rails close to the spokes. This does away with its staying power and that of all the other rails—each rail being firmly secured to this band—and leaves the rails free to close together like a fan.

Improved "Fly."

The only portion of this arrangement which will wear so as to affect the circumference of the fly is the tape band, which in time will stretch and allow of a slight shifting of the rails from their proper position; but this is easily remedied.

True Measure.

From endeavouring to reel as much yarn as possible reelers do not in general pick up their dropped ends soon enough, and for this reason it has become a rule of the trade to allow from one to three teeth extra in the bell wheel; and to thus keep the count of yarn correct enough without actually giving too good measure it is customary to keep the diameter of the reel from $\frac{1}{8}$ to $\frac{1}{32}$ of an inch less than the standard. One-eighth of an inch seems to be a large proportion to clip off a diameter of less than thirty inches, but it is really not too much where the reel may be rather close in the pitch for the lea of yarn being reeled, as the ends have then to be so much overlapped to keep the hanks separate as to cause the actual circumference of the fly to be more than 90in. when the yarn is on. For this reason reeling masters should pay particular attention to the shifters (which are the rails into which the reel pins and guides are affixed), that they travel or shift evenly and are in gear with the small pinion on the end, or are driven off the bell-wheel axle, and that the rate of shift is accurately calculated according to the lea of the yarn being reeled, so as to spread the yarn the requisite breadth of hank during the 12 revolutions of the bell wheel. He should also take care that the reelers do not lease their cuts too tight, so as to cause the hanks to look badly; to dry unevenly; and to show an undue number of snapped threads.

Even Hanks.

Hanks per Reel.

As coarse yarn takes up so much more room to the same length than does fine yarn, and as the usual length of the fly is found to be most suitable at about 100in. over all for heavy yarns, and about 110in. over all for the lighter yarns, there cannot be more than twenty-five pins in the reel, for coarse numbers, to leave sufficient spread for the hank, and thirty pins to the 110in. for the finer numbers.

The former style of reel is called a twenty-five-hank reel, and the latter a thirty hank reel, as there is one hank reeled to each pin. For the very coarsest numbers a twenty-hank reel will be a sufficient stretch for the reeler to keep under her eye, for the coarse and medium numbers a twenty-five-hank reel, for the fine a thirty-hank, and for the very finest yarns as close set a fly as thirty-five hanks to the 110in. if possible.

Length of Fly.

The necessity of paying some heed to the most suitable length for the fly in proportion to the lea of yarn to be reeled off it is obvious for two reasons—first, that it is the reeler's

business to see that no pin has ceased to deliver yarn from the fact of the bobbin having become empty whilst all the rest are still giving yarn off, as this will cause less yarn to be in this particular hank than in the rest, thus causing short count, every yard that passes on to the fly being measured and sold by measure to the manufacturer. Therefore if there be too many of these pins, if they be spaced sufficiently to allow of the coarsest yarn that will be reeled over that reel being sufficiently spread, there will be such an expanse of reel before the girl that she will not be able to have the necessary control over it. If, on the other hand, there be too few pins, as reelers are paid by piece work, the turn-off of reeled yarn from these short reels will not recompense the worker sufficiently for the time spent. The second reason for a well-regulated length of fly is, that if there be many pins in the coarse reels they will be very heavy when they are nearly full of yarn, and be more than the generality of women are fit to turn with the hand.

Ticket Hank.

Every reel or half-reel, according to the manner in which the wet yarn is put up, should have a ticket denoting lea and reeler's number tied to one of the hanks, to insure against mixing of yarn in the drying or bundling. The hank of every fifth reel in which the ticket is should be chain-leased—that is, the first six cuts should be entirely separated from the next six by two knots being interposed about half an inch apart, as according to the manner in which the bunches of yarn are put up—whether tied with their own yarn or with cord—depends the necessity for half hanks, and their being easily and safely divided from each other. These chain-leased hanks being also the ticket-hanks, admit of the man who puts up the yarn in bunches being able at once to pick out the chain-leased hanks from the rest, when he needs half hanks to become ties for his bunch of yarn.

Chain-leased Hank.

Full Bobbins.

Reelers sometimes show a disposition to retain unnecessarily the cages of bobbins off which they have reeled the yarn. This at first sight seems inexplicable, when it be remembered that their work is piece work, consequently one would think that the reeler would only be too glad to send her empty bobbins to the spinning room to be refilled. The reason is this : bobbins could not be filled too full of yarn to please reelers, as they then have less tying up, and so they endeavour to keep the spinning frame running as long as possible. Two or three gentle but firm admonishings on the part of the reeling master will, however, cure them of this trick ; nor will he take long to pounce upon them, as a good doffing mistress will not permit the bobbins to become too full, not only for the sake of preventing waste, but to save her doffers and herself from having more "ends" to lay. So when the bobbins are sufficiently filled the spinning frame is stopped, but the doffing of it is not proceeded with until the empty bobbins arrive. This dead loss of turn-off is soon seen by the spinning-master, and quickly, very quickly if there be a bonus, communicated to the reeling-master.

CHAPTER XX.

GENERAL REMARKS ON REELING.

HAVING, in the last chapter, gone minutely into the various ways and means by which every thread of yarn is measured after being spun, we will now discuss how an exact account of all this measured yarn is kept.

Taking in the Yarn.

A wooden rack, well raised off the floor and out from the wall and capable of holding a day's reeling, should run round the reeling room. The wet yarn being thus kept off the floor, and in a well-ventilated place, will not become dirtied nor be liable to sour.

The reeling-master should go round daily and inquire of each reeler how much yarn she has reeled, he setting down the amount thus named on a slate opposite to the number of the girl's reeling frame. This amount of yarn is given in in reels, to each of which there are twenty hanks.

After all the day's yarn is thus "taken-in," the reelers are ordered to bring their yarn to be passed to the drying-loft. The foreman of the latter has been supplied with a docket containing the number of reels of each sort of yarn that was entered on that day. The reeling-master receives this yarn—one sort at a time—from each girl, being careful to see that the reels received correspond with the number chalked against that particular girl on his slate. He then passes these reels down to the drying-loft, generally either down a spout or trough, or by a stretched wire and hooks ; as the reeling-room is usually in the upper storey of the building, and so on a higher level than the drying-loft. He at the same time checks off the quantity on his slate, as having been received from the girl who gave it in.

The reeling-master continues to pass down all the reels of the same class of yarn that may have been reeled, and on its becoming exhausted he must satisfy himself that the total passed down tallies with the total on his slate.

Yarn Docket.

The drying-loft man has to see that he receives the same number of reels as the quantity entered on his docket, this latter being simply a copy of the totals off the reeling-master's slate. Other sorts are then entered upon, until all the yarn reeled hitherto has been passed to the drying-loft.

Reelers' Wages Book.

Frame Book.

Yarn Book.

The reeling-master must then enter the contents of his slate into the "Reelers' Wages Book," and into the "Frame Book ;" the former to enable the clerk in the office to make up the reelers' pay, and the latter to act as a daily register of the "turn-off" of each frame. The contents of the yarn docket must be entered in the "Yarn Book," to insure against loss or alteration of the docket ; to be a handy reference for information as to the reels per day or per week of any sort that may be spinning ; and to guide the yarn stock-keeper in the balancing of his stocks.

Yarn Counters' Book.

Another, and the last, book necessary for the reeling-master to keep is the "Yarn Counters' Book," or, as it is more properly called, the Book of Fines. It is absolutely necessary that each reeler's work should be constantly checked by counting, this being effected by the reeling-master throwing to one side any one bundle of each reeler's day's work, and by his getting one hank out of each bundle counted.

Yarn counters can honestly count from 25 to 35 hanks of yarn daily, so that one yarn counter is required for every thirty reelers. In the counter's book there should be one page allotted to each reeler, with columns for reeler's name, number of frame, threads in each cut of the hank, total threads, threads over, threads short, amount of fine, date. Thus can the evenness of the girls' reeling and the amount of the fine be always to hand, and the correct transferring of the fine from this book to the wages book is rendered easy.

Yarn Counting.

As before remarked, reelers are paid by the amount of yarn reeled, at so much per reel, or per five reels, or per 100 hanks. This latter method is adopted in some places to save time in calculation, and, in case of an increase being granted in the rates, to make a better show.

Reelers' Fines.

It is not a difficult matter to lay down a scale of fines, as in case the yarn be very poor, the rates for reeling it are higher, so that the amount of earnings is about the same in both cases.

REELERS' FINES.

Threads short in Hank.	Fine. s. d.	Threads over in Hank.	Fine. s. d.
10	0 2	10	0 1
20	0 4	20	0 2
30	0 8	30	0 4
40	1 0	40	0 8
50	1 6	..	..
60	2 0	..	..
70	2 6	..	..
11 cut hank	1 0	Double-cut	3 0

The table of measure now generally adopted is as follows :—

YARN TABLE.

2½ yards, or	90 inches	=	one thread.
300 ,,	120 threads	=	one cut or lea.
3,600 ,,	12 cuts	=	one hank.
60,000 ,,	16 hanks and 8 cuts	=	one bundle.
72,000 ,,	20 hanks	=	one reel.
180,000 ,,	50 ,,	=	one 3-bundle bunch.
360,000 ,,	100 ,,	=	one 6-bundle bunch.
720,000 ,,	200 ,,	=	one 12-bundle bunch.

Here we see that a cut and a lea of yarn are one and the same thing, both signifying a length of 300 yards. Therefore, if yarn of one lea is spoken of, it is understood that of this particular yarn. There are only 300 yards to one pound weight; if the lea be 200's, there are 200 cuts or 60,000 yards to one pound.

Size of Yarns.

Thus is it that the sizes of yarns are regulated by weight, the standard being sixteen ounces (Avoirdupois), and the "lea" denoting so many cuts to this standard. Therefore it is that if the weight of one hank, ten hanks, or half a reel, twenty hanks, or one reel, sixteen and two-third hanks, or one bundle, etc., of any lea be required, the dividing of the lea into the total cuts in the quantity specified, will give the weight in pounds and fractions of a pound that quantity should weigh. If it does not weigh according to calculation, the specified quantity is really not that lea, but some other.

Calculation of Lea.

We will, for example, take a reel of 65's lea, the weight of which is :

```
      20 hanks one reel.
      12 cuts one hank.
      —
   65)240(3lbs. 11oz.
      195
      ——
       45
       16 oz.
      ——
      720
      715
```

So that, supposing that a reel of so-called 65's be weighed, and instead of being 3 pounds 11 ounces, is found to weigh 3 pounds 12 ounces, it is really not a reel of 65's lea, but—

3lbs. 12oz. = 3·75)240·00(64's lea.
225·00
15·00
15·00

To keep yarns to their proper weight, and thus, on the one hand, to save waste and the putting in of more than the requisite turns per inch, as is the case when yarns are spun too heavy; and, on the other hand, to prevent the yarn being too poor and slack twisted, as is the case when yarns are spun too light, it is advisable to prove each frame at least every second day. Those reels or half reels which have been counted and found to average near about the correct number of threads to the hank (1,440) are the best proofs that can be had, if they first of all be sent to the drying loft and be there dried to the proper degree (until no dampness is discernible where the hank is leased), and then allowed to cool down to an average temperature.

Yarn Proofs.

It should have been previously remarked that those reels of wet yarn which the reeling masters detained out of the day's work of each girl to be counted, should be separately entered on the dockets under the heading of "proofs;" thus at a glance explaining to the loftman the reason for less reels than the quantity entered coming down, and reminding both him and the foreman bundler of the quantity yet to be received.

In some establishments the proofs are reeled specially, so that the count may be assured, and this being done, the proofs are not the proper yarn to count, for this reason:—some reelers are so cunning as to give very short count in these proof reels, that there may be a tooth or two put upon the draft of the spinning frame. This of necessity improves the spin, and consequently causes the yarn to be more easily reeled; aye, and frequently, if the weighing of the proofs be entrusted to an interested party, even the weight may be set down at less than it really is, to show light leas.

Therefore, it should be the manager's special duty to weigh and record the proofs himself, in a book got up for the purpose, and containing a column for the number of the spinning frame, one for the leas, one for the pounds and ounces, one for the actual lea, and one for remarks. Having this, and a table posted up before him, containing the following particulars (or at least that portion of them which embraces his range of lea) he will have no difficulty in arriving at the actual lea being spun, and arranging accordingly.

Weighing the Proofs.

Of course the accompanying tables of "weights of leas," and also the beam and scales, should be arranged in some place convenient to the drying or bundling lofts, to prevent any unnecessary hawking about of the proofs.

We give leaf torn from "proof book."

WEIGHT OF TEN HANKS OF DRIED AND COOLED YARN.

Date.	No. of Frame.	Leas.	Lbs.	Oz.	Dr'ms.	Proving.	Remarks.
May 2nd	56	65's warp.........	1	12	11	67's	
,, ...	100	250's weft	0	7	13	245's	Will do.
,, ...	101	250's weft	0	7	4	260's	
,, ...	102	320's warp........	0	6	4	310's	
,, ...	5	18's tow	6	10	12	18's	
,, ...	6	18's tow	7	8	0	16's	Count.
,, ...	40	40's warp........	2	15	12	40¼'s	
,, ...	55	60's warp........	2	0	0	60's	
,, ...	54	70's weft	1	12	8	67's	1 tooth off.

WEIGHTS OF LINEN YARN LEAS.

Lea	12 Cuts 1 Hank	120 Cuts ½ Reel	240 Cuts 1 Reel	200 Cuts 1 Bundle	300 Cuts 1½ Bundle	400 Cuts 2 Bundles	600 Cuts 3 Bundles	900 Cuts 4½ Bundles	1200 Cuts 6 Bundles	2400 Cuts 12 Bundles
	lb. oz. dr.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.
8	1 8 0	15 0	30 0	25 0	37 7	50 0	74 14	..	..	..
9	1 5 5	13 5	26 10½	22 3	33 4½	45 6	66 8½	..	..	..
10	1 3 3	12 0	24 0	20 0	29 15	40 0	59 14½	..	..	..
11	1 1 7	10 14½	21 13	18 2½	27 4	36 5	54 8	..	..	..
12	1 0 0	10 0	20 0	16 10	24 15½	33 4½	49 15	..	..	..
13	0 14 12½	9 3¾	18 7½	15 5½	23 0½	30 11½	46 1	..	..	..
14	0 13 11½	8 9	17 2	14 4	21 6	28 8½	42 12½	..	..	..
15	0 12 13	8 0	16 0	13 5	19 15½	26 10	39 15	..	..	..
16	0 12 0	7 8	15 0	12 7½	18 11½	24 15½	37 7	..	..	..
17	0 11 5	7 1	14 2	11 12	17 10	23 8	34 4	..	..	..
18	0 10 11	6 10¾	13 5½	11 1½	16 10	22 3	33 4	49 14	66 7½	132 15½
19	0 10 1¾	6 5	12 10	10 8	15 12	21 0	31 8	47 4	63 0	126 0
20	0 9 9½	6 0	12 0	10 0	14 15½	20 0	29 15	44 15	59 14	119 12
21	0 9 2½	5 11½	11 7	9 8	14 4	19 0	28 8½	42 12½	57 0½	114 1
22	0 8 11½	5 7¼	10 14½	9 1	13 10	18 2½	27 4	40 14	54 7½	108 15½
23	0 8 5½	5 3½	10 7	8 11½	13 0	17 6	26 0½	39 1	52 1	104 2½
24	0 8 0	5 0	10 0	8 5	12 7½	16 10½	24 15	37 7	49 15	99 13½
25	0 7 11	4 12¾	9 9½	8 0	11 15½	16 0	24 0	36 0	48 0	96 0
26	0 7 6	4 9½	9 3	7 10½	11 7½	15 5	22 15½	34 7	45 15	91 13½
27	0 7 2	4 7	8 14	7 6	11 1½	14 12½	22 3	33 4½	44 6	88 12
28	0 6 14	4 4½	8 9	7 2	10 12	14 4	21 6½	32 1½	42 13	85 9½
29	0 6 10	4 2¼	8 4½	6 14	10 5	13 12	20 10	30 15½	41 4½	82 9
30	0 6 6½	4 0	8 0	6 10½	10 0	13 5	20 0	30 0	40 0	80 0
31	0 6 3	3 14	7 12	6 7	9 10½	12 14	19 5	28 15	38 9½	77 3
32	0 6 0	3 12	7 8	6 4	9 5½	12 7½	18 11½	28 1	37 7	74 14
33	0 5 13	3 10¼	7 4½	6 1	9 1½	12 1½	18 2½	27 4	36 5½	72 10½
34	0 5 10½	3 8½	7 1	5 14	8 13	11 11¾	17 10	26 7	35 3¾	70 7¾
35	0 5 7½	3 6¾	6 13½	5 11¼	8 8¾	11 6½	17 1½	25 10½	34 3¼	68 6½
36	0 5 5½	3 5¼	6 10½	5 8¾	8 5	11 1¼	16 10	24 15	33 3¾	66 7¾
37	0 5 3	3 4	6 8	5 6½	8 1½	10 12¾	16 2¾	24 4¼	32 5¾	64 11½
38	0 5 1	3 2½	6 5	5 4	7 14	10 8	15 12	23 10¼	31 8¼	63 0½
39	0 4 15	3 1¼	6 2½	5 1¾	7 10¾	10 3½	15 5½	23 0	30 11	61 5¾
40	0 4 13	3 0	6 0	5 0	7 7¾	10 0	14 15¾	22 7½	29 15½	59 14¾
41	0 4 11	2 14¾	5 13½	4 7½	7 4¾	9 12	14 9½	21 14½	29 3¼	58 6½
42	0 4 9½	2 13¾	5 11½	4 12	7 2	9 8	14 4¼	21 6¼	28 8¼	57 0½
43	0 4 7½	2 12½	5 9¼	4 10¼	6 14½	9 4½	13 12¾	20 11¼	27 9¼	55 3¼
44	0 4 6	2 11½	5 7¼	4 8½	6 13¼	9 1	13 10¼	20 7¼	27 4½	54 9
45	0 4 4½	2 10¾	5 5½	4 7	6 10½	8 14	13 5¼	19 15¾	26 10¼	53 4½
46	0 4 3	2 9¾	5 3½	4 7	6 8	8 11	13 0	19 8¼	26 0¼	52 0½
47	0 4 1	2 8¾	5 1½	4 3¾	6 5¾	8 7¾	12 11¾	19 1½	25 7¼	50 14¾
48	0 4 0	2 8	5 0	4 2½	6 6¾	8 5¼	12 7¾	18 11½	24 15½	49 14¾
49	0 3 15	2 7¼	4 14½	4 1¼	6 1¾	8 2½	12 3¾	18 5½	24 7¼	48 14¾
50	0 3 13½	2 6½	4 12¾	4 0	6 0	8 0	12 0	18 0	24 0	48 0
51	0 3 12	2 5½	4 11	3 14½	5 13¾	7 13¼	11 11¾	17 9½	23 7¼	46 14¾
52	0 3 11	2 5	4 10	3 13½	5 12	7 10¾	11 8¼	17 4¼	23 0¼	46 0½
53	0 3 10	2 4¼	4 8½	3 12¼	5 10¼	7 8½	11 4½	16 15	22 10	45 2¾
54	0 3 9	2 3½	4 7	3 11¼	5 9	7 6½	11 1½	16 10½	22 3¼	44 6½
55	0 3 8	2 3	4 6	3 10	5 7	7 4	10 14¼	16 5¼	21 12¼	43 9
56	0 3 7	2 2¼	4 4½	3 9	5 5½	7 2	10 11¼	16 0¾	21 6½	42 12¾

WEIGHTS OF LINEN YARN LEAS.—*Continued.*

Lea	12 Cuts 1 Hank	120 Cuts ½ Reel.	240 Cuts 1 Reel	200 Cuts 1 Bundle	300 Cuts 1½ Bundle	400 Cuts 2 Bundles	600 Cuts 3 Bundles	900 Cuts 4½ Bundles	1200 Cuts 6 Bundles	2400 Cuts 12 Bundles
	lb. oz. dr.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.
57	0 3 6	2 1¾	4 3½	3 8	5 4¼	7 0	10 8¼	15 12½	21 0½	42 1
58	0 3 5	2 1½	4 2	3 7	5 2½	6 14	10 5¼	15 7¾	20 10½	41 4¾
59	0 3 4	2 1	4 1¾	3 6¼	5 1¼	6 12½	10 2¾	15 4	20 5½	40 7½
60	0 3 3	2 0	4 0	3 5¼	4 15¾	6 10½	10 0	15 0	20 0	40 0
61	0 3 2½	1 15½	3 15	3 4½	4 14½	6 8½	9 13¼	14 12	19 10½	39 4¾
62	0 3 1½	1 14¾	3 13¾	3 3½	4 13¼	6 6¾	9 10¼	14 7¼	19 4½	39 9
63	0 3 0½	1 14½	3 12¾	3 2½	4 12	6 5¼	9 7¾	14 3¾	18 15½	37 15
64	0 3 0	1 14	3 12	3 2	4 11	6 3¾	9 5¾	14 0½	18 11½	37 7
65	0 2 15	1 13½	3 11	3 1	4 9½	6 2¼	9 3¼	13 13	18 6½	36 13¼
66	0 2 14½	1 13	3 10¼	3 0½	4 8½	6 0¾	9 1¼	13 10	18 2½	36 5¼
67	0 2 14	1 12½	3 9¼	3 0	4 7¼	5 15	8 14¾	13 6	17 13½	35 11
68	0 2 13	1 12¼	3 8½	2 15	4 6½	5 13¾	8 12¾	13 3¼	17 9½	35 3¼
69	0 2 12½	1 11¾	3 7½	2 14¼	4 5¼	5 12½	8 10¾	13 0	17 5½	34 11¼
70	0 2 12	1 11½	3 6¾	2 13½	4 4¼	5 11	8 8¾	12 13¼	17 1½	34 2¾
71	0 2 11½	1 11	3 6	2 13	4 3½	5 9¾	8 6¾	12 10¼	16 13¾	33 11¼
72	0 2 11	1 10¾	3 5½	2 12¼	4 2½	5 8¾	8 5¼	12 8	16 10½	33 5¼
73	0 2 10	1 10¼	3 4½	2 11¾	4 1½	5 7½	8 3¼	12 5	16 6½	32 13¼
74	0 2 9½	1 10	3 3¾	2 11	4 0½	5 6	8 1¼	12 1¾	16 2½	32 5¼
75	0 2 9	1 9½	3 3¼	2 10½	4 0	5 5¼	8 0	12 0	16 0	32 0
76	0 2 8½	1 9¼	3 2½	2 10	3 15	5 3¾	7 15¼	11 14¼	15 11½	31 7
77	0 2 8	1 9	3 1¾	2 9½	3 14	5 3	7 12½	11 10½	15 8¾	31 1¼
78	0 2 7½	1 8½	3 1¼	2 8¾	3 13½	5 1¾	7 10¾	11 8	15 5½	30 11¼
79	0 2 7	1 8¼	3 0½	2 8½	3 12¼	5 0¾	7 8¾	11 5	15 2½	30 5¼
80	0 2 6½	1 8	3 0	2 8	3 12	5 0	7 8	11 3¾	15 0	30 0
81	0 2 6	1 7¾	2 15½	2 7½	3 11¼	4 15	7 6¼	11 1½	14 12¾	29 9½
82	0 2 5½	1 7½	2 14¾	2 7	3 10½	4 14	7 4¾	10 15½	14 9½	29 3¼
83	0 2 5	1 7	2 14¼	2 6½	3 9¾	4 13	7 3½	10 13¼	14 7	28 13¾
84	0 2 4½	1 6¾	2 13½	2 6	3 9	4 12¼	7 2½	10 11	14 4¼	28 8¼
85	0 2 4	1 6½	2 13	2 5½	3 8½	4 11½	7 2	10 9	14 1½	28 3
86	0 2 3½	1 6¼	2 12½	2 5	3 8	4 10½	7 0	10 7¼	13 14¾	27 14
87	0 2 3	1 6	2 12	2 4½	3 7½	4 9½	6 14	10 5½	13 12	27 8
88	0 2 2¾	1 5¾	2 11½	2 4¼	3 6½	4 8½	6 12¾	10 3½	13 9¾	27 3½
89	0 2 2½	1 5½	2 11¼	2 3¾	3 5¾	4 7¾	6 11¾	10 1½	13 7¼	26 14¾
90	0 2 2¼	1 5¼	2 10½	2 3½	3 5¼	4 7	6 10½	9 15¾	13 5	26 10
91	0 2 2	1 5	2 10¼	2 3¼	3 4¾	4 6	6 9¼	9 14	13 2½	26 5¼
92	0 2 1½	1 4¾	2 9¾	2 2¾	3 4	4 5½	6 8¼	9 12¼	13 0	26 0½
93	0 2 1	1 4½	2 9¼	2 2¼	3 3½	4 4¾	6 7	9 10½	12 14	25 12
94	0 2 0¾	1 4¼	2 8¾	2 2	3 3	4 4	6 6	9 9	12 12	25 8
95	0 2 0¼	1 4¼	2 8½	2 1¾	3 2½	4 3¼	6 5	9 7¼	12 9¾	25 3½
96	0 2 0	1 4	2 8	2 1¼	3 2	4 2½	6 3¾	9 5¾	12 7¾	24 15½
97	0 1 15¾	1 3¾	2 7½	2 0¾	3 1¼	4 1¾	6 2¾	9 4¼	12 5½	24 10¾
98	0 1 15¼	1 3½	2 7¼	2 0½	3 0¾	4 1¼	6 1¾	9 2¾	12 3½	24 7
99	0 1 15	1 3¼	2 6¾	2 0¼	3 0½	4 0½	6 0¾	9 1	12 1½	24 3
100	0 1 14¾	1 3¼	2 6½	2 0	3 0	4 0	6 0	9 0	12 0	24 0
101	0 1 14½	1 3	2 6	1 15¾	2 15½	3 15¼	5 15	8 14¼	11 13¾	23 11½
102	0 1 14¼	1 2¾	2 5½	1 15¼	2 15	3 14¾	5 14	8 13	11 12	23 7¾
103	0 1 13¾	1 2½	2 5¼	1 15	2 14½	3 14	5 13	8 11½	11 11	23 6
104	0 1 13½	1 2½	2 5	1 14¾	2 14	3 13½	5 12	8 10¼	11 8¼	23 0½
105	0 1 13¼	1 2¼	2 4½	1 14½	2 13¾	3 12¾	5 11¼	8 9	11 6½	22 13¼
106	0 1 13	1 2¼	2 4¼	1 14¼	2 13¼	3 12¼	5 10½	8 7½	11 4¾	22 9½

WEIGHTS OF LINEN YARN LEAS.—*Continued.*

Lea	12 Cuts 1 Hank	120 Cuts ½ Reel	240 Cuts 1 Reel	200 Cuts 1 Bundle	300 Cuts 1½ Bundle	400 Cuts 2 Bundles	600 Cuts 3 Bundles	900 Cuts 4½ Bundles	1200 Cuts 6 Bundles	2400 Cuts 12 Bundles
	lb. oz. dr.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.
107	0 1 12¾	1 2	2 4	1 13¾	2 12¾	3 11¾	5 9½	8 6¼	11 3¼	22 6¼
108	0 1 12½	1 1¾	2 3½	1 13½	2 12¼	3 11¼	5 8¾	8 5¼	11 1¾	22 3
109	0 1 12¼	1 1½	2 3¼	1 13¼	2 12	3 10¾	5 8	8 3¾	10 15¾	22 0
110	0 1 12	1 1½	2 2¾	1 13	2 11¾	3 10	5 7	8 2¾	10 14¼	21 12¾
111	0 1 11¾	1 1¼	2 2½	1 12¾	2 11	3 9½	5 6¼	8 1½	10 12½	21 9
112	0 1 11½	1 1	2 2¼	1 12½	2 10¾	3 9	5 5½	8 0	10 11	21 6¼
113	0 1 11¼	1 1	2 2	1 12¼	2 10½	3 8½	5 4¾	7 15¼	10 9½	21 3¼
114	0 1 11	1 0¾	2 1½	1 12	2 10¼	3 8	5 4	7 14¼	10 8	21 0¼
115	0 1 10¾	1 0½	2 1¼	1 11¾	2 9¾	3 7½	5 3	7 12½	10 6¾	20 13½
116	0 1 10½	1 0¼	2 1	1 11½	2 9½	3 7	5 2½	7 12	10 5¼	20 10½
117	0 1 10¼	1 0¼	2 0¾	1 11¼	2 9¼	3 6¾	5 2	7 11	10 4	20 7¾
118	0 1 10	1 0¼	2 0½	1 11	2 8¾	3 6¼	5 1¼	7 9¾	10 2½	20 4¾
119	0 1 9¾	1 0	2 0¼	1 10¾	2 8¼	3 5¾	5 0½	7 9	10 1	20 2
120	0 1 9½	1 0	2 0	1 10½	2 8	3 5¼	4 15¾	7 8	10 0	19 15¾
121	0 1 9¼	1 0	1 15¾	1 10¼	2 7¾	3 5	4 15¼	7 7	9 14½	19 13
122	0 1 9	0 15¾	1 15½	1 10	2 7½	3 4½	4 14½	7 5¾	9 13¼	19 10¼
123	0 1 9	0 15½	1 15¼	1 9¾	2 7	3 4	4 14	7 4¾	9 12	19 6½
124	0 1 8¾	0 15½	1 15	1 9¾	2 6¾	3 3½	4 13½	7 4	9 10¾	19 5¼
125	0 1 8½	0 15½	1 14¾	1 9½	2 6¼	3 3¼	4 12¾	7 3	9 9½	19 2½
126	0 1 8¼	0 15¼	1 14½	1 9¼	2 6	3 2¾	4 12	7 2	9 8¼	19 0
127	0 1 8¼	0 15¼	1 14¼	1 9	2 5¾	3 2¼	4 11½	7 1	9 7	18 13¾
128	0 1 8	0 15	1 14	1 9	2 5½	3 2	4 11	7 0	9 5¾	18 11½
129	0 1 7¾	0 15	1 13¾	1 8¾	2 5	3 1½	4 10¼	6 15	9 4½	18 9¼
130	0 1 7½	0 14¾	1 13½	1 8½	2 4¾	3 1¼	4 9¾	6 14½	9 3½	18 7
131	0 1 7¼	0 14¾	1 13¼	1 8¼	2 4½	3 0¾	4 9¼	6 13¾	9 2½	18 4¾
132	0 1 7	0 14½	1 13	1 8¼	2 4¼	3 0½	4 8½	6 12¾	9 1¼	18 2¼
133	0 1 6¾	0 14½	1 12¾	1 8	2 4	3 0	4 8	6 12	9 0	18 0
134	0 1 6½	0 14¼	1 12½	1 7¾	2 3¾	2 15¾	4 7½	6 11¼	8 15¼	17 14
135	0 1 6¼	0 14¼	1 12¼	1 7½	2 3½	2 15¼	4 7	6 10½	8 14	17 12
136	0 1 6¼	0 14	1 12	1 7¼	2 3¼	2 15	4 6½	6 9¾	8 13	17 9¾
138	0 1 6	0 14	1 11¾	1 7	2 2¾	2 14¼	4 5¾	6 8¼	8 11¼	17 5¾
140	0 1 5¾	0 13¾	1 11½	1 6¾	2 2¼	2 13¾	4 4¾	6 6¾	8 9	17 1¾
142	0 1 5½	0 13¾	1 11	1 6½	2 1¾	2 13	4 3½	6 5¼	8 7	16 14
144	0 1 5¼	0 13½	1 10½	1 6¼	2 1¼	2 12½	4 2½	6 4	8 5	16 10¼
146	0 1 5	0 13¼	1 10¼	1 6	2 0¾	2 11¾	4 1¾	6 2¾	8 3¼	16 6½
148	0 1 4¾	0 13	1 10	1 5½	2 0½	2 11	4 0¾	6 1¼	8 1¼	16 2¼
150	0 1 4½	0 12¾	1 9½	1 5¼	2 0	2 10½	4 0	6 0	7 15¼	16 0
152	0 1 4¼	0 12½	1 9¼	1 5	1 15¾	2 10	3 15	5 14½	7 14	15 12
154	0 1 4	0 12½	1 9	1 4¾	1 15¼	2 9½	3 14¼	5 13¼	7 12½	15 9
156	0 1 3¾	0 12¼	1 8½	1 4½	1 14¾	2 9	3 13½	5 12	7 11	15 5¾
158	0 1 3½	0 12	1 8¼	1 4¼	1 14½	2 8½	3 12¾	5 11	7 9¼	15 2¾
160	0 1 3¼	0 12	1 8	1 4	1 14	2 8	3 12	5 10	7 7¾	15 0
162	0 1 3	0 11¾	1 7½	1 3¾	1 13½	2 7½	3 11	5 8¾	7 6¼	14 12½
164	0 1 2¾	0 11¾	1 7¼	1 3½	1 13¼	2 7	3 10½	5 7½	7 4¾	14 9½
166	0 1 2½	0 11½	1 7	1 3¼	1 13	2 6½	3 9¾	5 6½	7 3½	14 7
168	0 1 2¼	0 11½	1 6¾	1 3	1 12½	2 6	3 9	5 5½	7 2	14 4
170	0 1 2	0 11¼	1 6½	1 2¾	1 12¼	2 5½	3 8¼	5 4½	7 0¾	14 1½
172	1 1 1¾	0 11	1 6¼	1 2½	1 12	2 5¼	3 7¾	5 3½	6 15½	13 15
174	1 1 1½	0 11	1 6	1 2¼	1 11½	2 4¾	3 7	5 2¾	6 14¼	13 12½

WEIGHTS OF LINEN YARN LEAS.—*Continued.*

Lea	12 Cuts 1 Hank	120 Cuts ½ Reel	240 Cuts 1 Reel	200 Cuts 1 Bundle	300 Cuts 1½ Bundle	400 Cuts 2 Bundles	600 Cuts 3 Bundles	900 Cuts 4½ Bundles	1200 Cuts 6 Bundles	2400 Cuts 12 Bundles
	lb. oz. dr.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.
176	0 1 1¼	0 10¾	1 5¾	1 2	1 11¼	2 4¼	3 6½	5 1¾	6 13	13 10
178	0 1 1¼	0 10¾	1 5½	1 1¾	1 11	2 3¾	3 5¾	5 0¾	6 11¾	13 7¼
180	0 1 1	0 10¾	1 5¼	1 1¾	1 10¾	2 3½	3 5¼	4 15¾	6 10¾	13 5¼
182	0 1 0¾	0 10½	1 5	1 1½	1 10¼	2 3	3 4¾	4 15	6 9¼	13 2¾
184	0 1 0½	0 10½	1 4¾	1 0¾	1 10	2 2¾	3 4	4 14	6 8	13 0½
186	0 1 0½	0 10¼	1 4½	1 0½	1 9¾	2 2¼	3 3½	4 13¼	6 7	12 14
188	0 1 0¼	0 10¼	1 4¼	1 0¼	1 9½	2 2	3 3	4 12½	6 6	12 12
190	0 1 0	0 10	1 4¼	1 0¼	1 9¼	2 1¾	3 2½	4 11¾	6 5	12 9¾
192	0 1 0	0 10	1 4	1 0	1 9	2 1¼	3 2	4 11	6 3¾	12 7¾
194	0 0 15¾	0 10	1 3¾	0 15¾	1 8¾	2 0¾	3 1¼	4 10	6 2¾	12 5¼
196	0 0 15¾	0 9¾	1 3½	0 15½	1 8½	2 0½	3 0¾	4 9¼	6 1¾	12 3½
198	0 0 15½	0 9¾	1 3½	0 15½	1 8¼	2 0¼	3 0½	4 8½	6 0¾	12 1½
200	0 0 15¼	0 9½	1 3¼	0 15¼	1 8	2 0	3 0	4 7¼	6 0	12 0
202	0 0 15¼	0 9½	1 3	0 15¼	1 7¾	1 15½	2 15½	4 7	5 14¾	11 13½
204	0 0 15	0 9½	1 2¾	0 15	1 7½	1 15¼	2 15	4 6½	5 13¾	11 11¾
206	0 0 15	0 9¼	1 2½	0 15	1 7¼	1 15	2 14½	4 5¾	5 13	11 10
208	0 0 14¾	0 9¼	1 2½	0 14¾	1 7	1 14¾	2 14¼	4 5¼	5 12¼	11 8¼
210	0 0 14½	0 9	1 2¼	0 14½	1 6¾	1 14½	2 13¾	4 4½	5 11¼	11 6½
212	0 0 14½	0 9	1 2	0 14½	1 6½	1 14	2 13¼	4 3¾	5 10½	11 5
214	0 0 14¼	0 9	1 2	0 14¼	1 6¼	1 13¾	2 12¾	4 3¼	5 9½	11 3¼
216	0 0 14¼	0 8¾	1 1¾	0 14¼	1 6	1 13½	2 12½	4 2¾	5 8¾	11 1¼
218	0 0 14	0 8¾	1 1½	0 14	1 6	1 13¼	2 12	4 1¾	5 7¾	11 0
220	0 0 14	0 8¾	1 1½	0 14	1 5¾	1 13	2 11½	4 1¼	5 7	10 14¼
225	0 0 13¾	0 8½	1 1	0 13¾	1 5¼	1 12½	2 10¾	3 15¾	5 5¼	10 10¼
230	0 0 13½	0 8½	1 0½	0 13¾	1 4¾	1 11¾	2 9¾	3 14½	5 3¼	10 6¾
235	0 0 13¼	0 8¼	1 0¼	0 13¼	1 4½	1 11¼	2 8¾	3 13¼	5 1½	10 3¼
240	0 0 13	0 8	1 0	0 13	1 4	1 10¾	2 8	3 12	4 15¾	10 0
245	0 0 12½	0 7¾	0 15½	0 12¾	1 3¾	1 10	2 7	3 10½	4 14¼	9 12¼
250	0 0 12¼	0 7½	0 15¼	0 12¼	1 3¼	1 9½	2 6¼	3 9½	4 12¾	9 9¼
255	0 0 12	0 7½	0 15	0 12	1 2¾	1 9	2 5¾	3 8½	4 11¼	9 6¼
260	0 0 11¾	0 7¼	0 14¾	0 11¾	1 2½	1 8½	2 5	3 7¼	4 9¾	9 3½
265	0 0 11½	0 7¼	0 14½	0 11½	1 2	1 8	2 4	3 6¼	4 8¼	9 0½
270	0 0 11¼	0 7	0 14¼	0 11¼	1 1¾	1 7½	2 3½	3 5¼	4 7	8 13¾
275	0 0 11	0 7	0 14	0 11	1 1½	1 7¼	2 2¾	3 4¼	4 5¾	8 11½
280	0 0 11	0 7	0 13¾	0 11	1 1¼	1 6¾	2 2¼	3 3½	4 4½	8 9
285	0 0 10¾	0 6¾	0 13½	0 10¾	1 0¾	1 6½	2 1¼	3 2½	4 3¼	8 6½
290	0 0 10½	0 6¾	0 13¼	0 10½	1 0½	1 6	2 1	3 1½	4 2	8 4
295	0 0 10½	0 6½	0 13	0 10½	1 0¼	1 5½	2 0½	3 0¾	4 1	8 2
300	0 0 10¼	0 6½	0 12¾	0 10¼	1 0	1 5¼	2 0	2 15¾	4 0	8 0
305	0 0 10	0 6¼	0 12½	0 10	0 15¾	1 5	1 15½	2 15	3 14¾	7 13¼
310	0 0 9¾	0 6¼	0 12¼	0 9¾	0 15½	1 4½	1 15	2 14½	3 13¾	7 11¾
315	0 0 9¾	0 6	0 12¼	0 9¾	0 15¼	1 4¼	1 14½	2 13¾	3 12¾	7 9½
320	0 0 9½	0 6	0 12	0 9½	0 15	1 4	1 14	2 13	3 11¾	7 8
325	0 0 9½	0 6	0 11¾	0 9½	0 14¾	1 3¾	1 13½	2 12¼	3 11	7 6
330	0 0 9¼	0 5¾	0 11½	0 9¼	0 14½	1 3¼	1 13	2 11½	3 10¼	7 4¼
335	0 0 9¼	0 5¾	0 11½	0 9¼	0 14¼	1 3	1 12½	2 11	3 9¼	7 2½
340	0 0 9	0 5½	0 11¼	0 9	0 14¼	1 2¾	1 12¼	2 10¼	3 8½	7 0¾
345	0 0 8¾	0 5½	0 11	0 8¾	0 14	1 2½	1 11¾	2 9¾	3 7½	6 15½
350	0 0 8½	0 5¼	0 10¾	0 8½	0 13¾	1 2¼	1 11¼	2 9	3 6¾	6 13½

The reeling-master should train his reelers to use scissors and insist upon their using them and not knives for clipping their ends, as there is often a too frequent use made of the knife, as the waste will show, whereas scissors cannot be used in the same manner.

Yarn Clippings.

The cuttings or clippings should not be permitted to drop in among the yarn on the reel as a large proportion of them would not again drop out, and would only cause waste and loss of time in the weaving department.

Weaver's Knot.

The round loose knot should be strictly prohibited, and none but the weaver's knot tied. This knot is made by crossing the end in the left hand over that in the right, by then bringing up the right hand end over the thumb nail in the form of a loop round its own top end, and then down between it and the left hand end. The left hand end must now be pushed over the right hand end and through the loop, thus laying the left hand end alongside the lower portion of itself. Then let all go except this doubled left hand end and pull the loop tight over it by means of the portion of the right hand loop that remains between the fingers. The knot is now tied, and has the peculiarity of getting tighter the more it is pulled.

Mixed, etc., Yarn.

Reelers should also be trained to leave out any bobbins of yarn that they see to be different from the rest, as mixed, beaded, stained, striped, lumped, shired, dirtied, ravelled, double or single yarn ; so that the reeling-master may at once send these bobbins to the spinning-master and thus get the evil looked up and put a stop to. This system being firmly insisted upon will result in the manufacturer having the minimum of complaints to make, and will consequently eventuate in matters being more satisfactory and more remunerative to all parties concerned.

Reel Guides.

Until recently wire guides set in the reel shifter before the spindle were exclusively in use, but it did not take much discrimination to find out that they were not all that could be desired ; as, with the constant friction, the wire soon became cut or serrated by the yarn, causing the wire guides to become injurious to the yarn both as regards its appearance and its reeling capacity.

Among many improved reel guides one stands pre-eminent for durability and effectiveness. It is simply a grooved fork of cast iron into which is inserted a well-finished fork of delft, so smooth and hard glazed that the friction of the yarn does not seem to have any effect upon it ; this consequently reduces to a minimum the strain upon the end, which consummation is especially to be desired. An endeavour to reduce to a minimum all unnecessary friction has given rise to the custom of having the reel spindles of small enough size to take on a brass socket of fairly loose fit for the bore of the bobbin, the bottom of this socket being dish-shaped to secure the least possible bearing upon the shifter and to act as a support for the bobbin. When these sockets become worn and too flat it is very beneficial to insert boxwood washers between them and the shifter to reduce the strain upon the end of the yarn. So effective has this arrangement proved in reeling that in many cases similar washers are inserted under the bobbins of those spinning frames producing poor or fine weft yarns to improve the spin.

Reel Sockets.

Short-reel.

To reduce to the utmost the wear and tear upon the finer yarns, and for general convenience and effectiveness, it is customary to reel them "short-reel." This is accomplished by making use of a small light "fly" raised up close to the shifter to secure the shortest distance from the bobbin to the point of contact with the surface of the fly, and by adopting the following scale of "short-reel measurement":—

1½ yards or	54 inches	= one thread.
150 ,,	100 threads	= one cut.
1,800 ,,	12 cuts	= one hank.
36,000 ,,	20 hanks	= one half-reel.
60,000 ,,	33⅓ hanks	= one bundle.
72,000 ,,	40 hanks	= one reel.
180,000 ,,	100 hanks	= three bundles.
360,000 ,,	200 hanks	= six bundles.
720,000 ,,	400 hanks	= twelve bundles.

Reelers' Rates.

There remains nothing more to be noted regarding the reeling department, except to again mention that it is not feasible to tabulate any standard rate of wages for reelers, so much depends upon the quality and lea of the yarn to be reeled, etc., etc.; but, as showing the increase that has taken place in the earnings of women in this department during the last 20 or 25 years, it is worthy of mention that the average weekly wages earned by a fair class of reeler in the year 1855 was from 5s. to 7s., whereas, in the year 1875, the same woman could earn from 8s. to 11s. per week. We subjoin a comparative

REELERS' WAGES SCALE.

	Tow Warp.	Tow Weft.	Long Reel. Line. Warp.	Long Reel. Line. Weft.	Short Reel. Line. Warp.	Short Reel. Line. Weft.
	d.	d.	d.	d.	d.	d.
12's and 16's	9½	10	....		....	
18's — 25's	8½	9	....		....	
28's — 50's	8	8½	....		....	
14's — 25's	....	....	8	9	....	
28's — 70's	....	....	7	8	9	10
75's — 85's	....	....	7½	8½	9½	10½
90's — 100's	....	....	8	9½	10	11
110's	....	....	8½	10½	10½	12
120's	....	....	9	11	11	12½
130's	....	....	9½	11½	11½	13
140's	....	....	10	12	12	13½
150's	....	....	11	13	12½	14½
160's	....	....	12	14	13	15
170's	....	....	13	15	14	16
180's	....	....	14	16	15	17
190's	....	....	15	17	16	18
200's	....	....	16	18	17	19
210's	....	....	....		18	20
220's	....	....	....		19	21
230's	....	....	....		20	22
240's	....	....	....		21	23
250's	....	....	....		22	24
260's	....	....	....		23	25
270's	....	....	....		24	26
280's	....	....	....		25	27
290's — 300's	....	....	....		26	28

Per 100 hanks of 3,600 yards each, long reel.

CHAPTER XXI.

YARN DRYING AND BUNDLING.

If a spinning concern be well adapted to its object, the yarn can be properly dried at a merely nominal expense, by having all the boilers ranged close together under one roof, which will allow sufficient area over them for the thorough drying of all the yarn that they are capable of generating steam for the spinning of, in from 12 to 20 hours, provided that there be no auxiliary water-power. It is proper to have three stages or lofts over the boilers, the floor of each being open woodwork grating, constructed to give the greatest strength with the least quantity of framing, so as to give free access to the heat. The first floor should not be more than 6ft. from the top of boilers, and the floors of each loft about 8ft. apart, so as to be as compact as possible. The roof should be opened up in its apex along its whole length, with well-regulated air panes, louvres, and ventilators, to allow of the loft being thoroughly ventilated during all weathers.

Drying-loft.

Ranged along each loft are stout parallel frames called "runs," which support wooden poles of about 9ft. in length, stretching transversely from one run to the other, at the height of about 5ft. from the floor. Between each of these runs of poles, and around each loft, should be a "pass" for the speedier getting at the yarn and the stripping it off the poles. At convenient distances along these passes should be trap doors for the ready passing down of the yarn from one loft to another. Yellow pine makes the best yarn pole, being freest from shakes, splints, knots, etc., and being less liable to warp with the extreme heat than other descriptions of wood of as light and handy a nature. These poles shou.d be about 3in. in diameter, and octagonal, to separate the yarn sufficiently and to allow of its being dried to the greatest advantage where it encircles the pole. If the wood be thoroughly seasoned, and the poles get two or three light coats of paint, they will keep straight and smooth, and will not be nearly so likely to splint up round their ends, where they are constantly fraying against the runs, as if they be put into work unseasoned and unpainted. It is scarcely necessary to remark that nothing is more injurious to the yarn than frayed poles or floor slips, as these tear and destroy any yarn that comes in contact with them. Unpainted poles require to be closely looked after, for this reason, and frequently sent to the carpenters' shop to be planed up anew.

Yarn Poles.

All yarns, but especially line yarns, should be stretched over two poles. This is done by passing the reel or half reel of wet yarn over two poles on the run; then by spreading each hank separately to the full breadth of its "leasing" on the pole, and regulating the number of hanks to each pole according to the lea of the yarn and the heat of the loft at that particular place, the lowest loft being the hottest and the upper one the coolest. When the wet yarn is all spread, the length of time that the yarn must remain on the pole depends upon the spreading and the distance that the poles can be kept apart, as the closer the hanks are together the nearer the poles are to each other, and the more the quantity of yarn overhead, so much the longer will be the yarn in drying.

Yarn Drying.

On the proper number of hanks, varying from twenty to sixty according to lea and accommodation, being spread over the poles, and the leased portions of the hanks in a line, the attendant lifts one of the poles out of the run and lets it drop to the bottom of that row of hanks. He, or she, then takes hold of the upper pole and rolls it backwards and forwards along the run until the hanks are as well spread round the lower as the upper pole. The leased portion of the hank is the hardest to dry, consequently it must be kept from coming in contact with the poles, and, at the same time, to the front and upper side, to facilitate reference to the ticket of distinction here leased in.

Aids to Drying. In murky weather it is sometimes very difficult to ensure the yarn being properly dried within the allotted time, especially about the leased portion and that surrounding the yarn poles. This is especially the case if the direction of the wind be unfavourable to the ventilating arrangements, and it may occur even with the thinnest spreading of the yarn over the poles that space will admit of, and which light spreading the foreman may have adopted as a precautionary measure. This although it is against his interest to scatter his yarn over too extensive an area, as he and his men are generally paid so much per thousand hanks.

In concerns where these difficulties are experienced the ordinary method of ventilation should be supplemented by screw-fan ventilators, or even by the following more elaborate arrangement. A large bell-mouthed trough, extending the whole length of the open part of the roof of the drying loft, with a Schiele fan at its extremity to draw up and expel the damp air, will be found very effective; or, if the chimney-stalk be convenient, the letting in of the extremity of the trough into its side will produce as strong, and more constant a draught than will the Schiele's fan.

Ordinary intelligence and practice will soon enable the dry-loft men so to regulate the distance of the poles from each other on the "run," and to choose the best position for different qualities and lea of yarn, as to cause all yarn on the loft to be properly dried in about the same time. This facilitates, to a great extent, the rolling of the dried yarn into bundles of ten hanks each, and the quick stripping of these half reels off the poles on to different piles, according to sort. From these piles the yarn can be correctly received by the bundlers—men whose duty it is to receive the yarn, at this stage, from the drying-loft, and who carry it to the bundling-room, to be there prepared by them for going into stock, or to be placed on the market.

Drying Machine. From a large portion of the motive power being water, or from some other reason, it often happens that the boilers either are too few or they cannot be centralised, so that there is either too little heat, or else what there is cannot be utilised for drying-loft purposes. In such a case recourse is had to a system of steam-piping arranged round and through the loft to dry the yarn; but this is expensive, especially if the steam has to be piped any distance from the boilers. To meet this difficulty, and to economise space, a drying-machine has been some time since brought out by Mather and Platt, of Salford, which is in many instances very efficacious.

This drying-machine is composed of a number of patent tin cylinders of large size working parallel to each other and in contact in a large cast iron frame prepared for their reception. Every alternate cylinder is slightly elevated for the better conducting of the yarn over and under them, and to cause the yarn to be more boxed-up between them. The cylinders are, of course, hollow and steam tight, as are also the cylinder axles and the frame work in which these hollow axles revolve. Thus the frame work and axles

become the medium for conducting the steam from the steam pipe through the axles and into the cylinders.

The cylinders are driven by gearing and their peculiarity consists in all their joints and bearings being perfectly steam-tight and simple of construction, so that on wearing off the truth they may be easily packed with rings of cotton-tape soaked in tallow, this packing best resisting the action of the steam, with the minimum of friction. Ingeniously placed in one of the ends of each cylinder is a little valve which opens for a moment at each revolution of the cylinder to allow the condensed steam to escape without the waste of any of the steam itself.

There are brass rods called "hooks" for holding the yarn; they are about fifteen or eighteen inches long and can contain from four to eight hanks of yarn according to lea, the speed that the machine is driven at and the pressure of the steam in the cylinders—all these items being adjustable at pleasure. On the hanks being hooked on, these brass clips or hooks are passed in through a pair of wooden feed-rollers into the machine. Thus is the layer of wet yarn drawn in, and each succeeding layer of yarn is hooked on to the end of the one passing in, so that in this manner a continuous length of yarn (or lengths, as there are generally three sets of hooks across the face of the machine) is passing in and over and under the scorching rollers, and then out at the front of the machine, perfectly dried and stretched and pressed during its progress through the machine, which occupies from seven to fifteen minutes. Various arguments are advanced both for and against these drying machines, and we will now inquire into a few of them.

In their favour is the room saved, the expeditious drying, and the improved and glossy appearance given to the yarn that passes through them. Against them is the quantity of steam used, the difficulty and expense of keeping them in repair, and the fact that the yarn is much marked or compressed where it was in contact with the hooks, and not thoroughly dried at these spots. But the latter objection is entirely removed by having, in conjunction with the drying machines, what should be in connection with every spinning concern, a "cooling shed," or large airy flat for bringing the yarn to after it is dried, and letting it lie there for from twelve to twenty-four hours to cool.

Cooling-shed.

This cooling "brings back" the over-dried portions of the yarn to the normal temperature, restoring strength and insuring a yarn of a more level and finished appearance on its being opened out of the bunch. Those portions of the yarn which may not have been sufficiently dried are soon brought to an equality with the rest by lying in contact with the warm dry portions for hours, and that which has been too much dried is cooled down; whereas in places where there is either not room or the desire to keep a cooling shed it is absolutely necessary to damp the yarn with water to cool it and to bring it to its average weight. By this arrangement the undried portions of the yarn must receive as large a portion of the water as the dried, which results in some portions of the bunch being either too dry or else too wet, giving a rough and unfinished appearance to the yarn. The best floor for a cooling shed is a well-drained red clay bottom, covered with a layer of well-puddled lias lime and fat loam, about 9in. deep, the layer, on becoming firm, to be well pounded and rolled. When the floor has got time to dry out it is hard, level, and cool, and when covered with bass matting affords every facility for the quickest and most general cooling of the yarn on both top, bottom, and sides, without fear of damp or blue-mould; and besides, there is no woodwork to splinter up, and so drag and tear the yarn.

Cooled Proofs.

It is after the yarn is thus cooled that the proofs should be weighed, and in this may be found one of the key-notes of

the successful management of a spinning mill, as, if a proof, evenly cooled and of correct count, weigh two or three leas more or less than on a previous day, and there has been no change whatever made upon the spinning frame, this is proof positive of some carelessness in the preparing department; or if a particular sort of yarn on, say, four or five separate frames suddenly becomes too light or too heavy, without any apparent cause, it is not difficult to trace the error to its source, and put a stop to it for the future. If there be any tampering with the spinning frames it is also at once detected here, as the alteration of twist alone will cause a slight difference in the proofs. This sharp looking after each frame separately not only insures the yarn appearing to the greatest advantage, but soon causes the frames to be so well regulated that scarcely one has to be altered; where perhaps, otherwise, a whole set of frames must be lightened or the reverse on a particular count of yarn weighing heavy or light in the bunch; and if this yarn had been spun some days before, and has had time to come right again, the alteration only makes matters worse, and is sure to have to be again undone.

Yarn Bunching.

We have the yarn now ready for bunching, commonly called bundling. It has to be put in bunches of any size, from one to twelve bundles each, according to the lea and the requirement of the manufacturer and the capacity of the yarn presses. The bundler takes an armful of the loose dry yarn and throws it over a horizontal pole called a "horn." He then selects the proper number of hanks from this lot, and levels and shakes them on the horn to prepare them for "heading."

"Heading."

This operation is performed as follows: Catch these hanks near the middle in each hand, keeping the palms of the hands down over the yarn, hold the yarn stationary in the left hand, and pass the portion that is in the right hand under the left arm, thus giving the yarn a half twist. Then take the portion that is in the left hand into the right, not allowing the twist to fly out, catch the portion under the left arm in the left hand and twist it round under the portion that is in the right hand, holding both halves firmly in the right hand. These halves being exactly the same length, and the middle so well twisted together that on laying it down it will not come out, constitutes proper heading, and there are so many of these heads in each bunch. The heads are then lifted off a table at hand by the pressman and laid in the press,

"Pressing."

which is composed of brass jaws or ribs in front and rear, closed in by caps of brass, which close over them and are bolted down. The ends of the press are entirely open, and the bottom is attached to a stud-wheel and lever, which forces the moveable bottom upwards into the press. There are channels cut on the upper side of the bottom, at right angles to the ribs and right between them, in which are laid the tieings of the bunch, whether cuts, half cut, or cord, and transversely over these are laid the heads to be pressed. On the requisite number of heads being placed and levelled up in the press the caps are bolted down, and by the aid of handles or levers the pressman screws up the yarn in the press to any extent that may be necessary. He then lifts the ends of the ties and loosely knots them round the compressed bunch. The releasing of the pressure soon stretches the ties securely tight, the bolts are then withdrawn, the caps lifted, and the bunch turned out ready for the market, all except the ticket. The size of the presses and the quantity to be pressed depends upon the lea, as most bunches have to be compressed sufficiently to admit of their being tied with their own cuts. The following will give a fair idea of the sizes of presses, inside measurement:

Yarn Presses.

For very coarse lea up to three bundles, and for coarse lea up to six bundle bunches, long reel, a press 20in. long by 10in. broad by 10in. by 19in. deep; for medium lea six bundle bunches, and

YARN PRICE LIST.

Lea.	P Prime Wp.	1 Warp.	2 Medium.	3 Weft.	Lea.	P Prime Wp.	1 Warp.	2 Medium.	1 Warp.
7	25/	..	..	..	75	11/3	8/3	6/	5/
8	23/	..	..	..	80	12/	8/6	6/	4/9
9	21/	..	..	..	85	13/	8/9	6/	4/6
10	19/	17/	..	..	90	14/	9/	6/3	4/6
11	17/6	16/	..	..	95	15/	9/3	6/6	4/6
12	16/6	15/	14/6	..	100	16/	9/6	6/9	4/6
14	15/6	14/	13/3	12/6	110	17/6	10/3	7/3	4/6
16	14/6	13/	12/3	11/6	120	19/	11/	7/9	4/6
18	13/6	12/	11/3	10/3	130	20/6	11/9	8/3	4/6
20	12/9	11/3	10/6	9/6	140	22/	13/	8/9	4/9
22	12/	10/6	10/	9/	150	24/	14/	9/6	5/3
25	11/6	10/	9/6	8/6	160	..	15/	10/3	6/
28	11/	9/6	9/	8/	170	..	16/	11/	6/9
30	10/6	9/3	8/9	7/9	180	..	17/	11/9	7/6
32	10/	9/	8/6	7/6	190	..	18/	12/6	8/3
35	9/9	8/9	8/3	7/3	200	..	19/	13/3	9/
38	9/6	8/6	7/9	7/	210	..	..	14/	9/9
40	9/3	8/3	7/6	6/9	220	..	..	14/9	10/6
42	9/	8/	7/3	6/6	230	..	..	15/6	11/3
45	9/	7/9	7/	6/6	240	..	..	16/3	12/
48	9/	7/9	6/9	6/3	260	..	..	17/6	13/
50	9/	7/9	6/6	6/3	280	..	..	18/6	14/
55	9/	7/9	6/3	6/	300	..	..	..	15/
60	9/3	7/9	6/	5/9	330	..	..	..	16/
65	9/9	7/9	6/	5/6	350	..	..	..	17/
70	10/6	8/	6/	5/3	380	..	..	..	18/

fine lea twelve bundle bunches, long reel, a press 20in. long by 9½in. broad by 7½in. by 17½in. deep; for fine lea six bundle bunches, and very fine lea 12 bundle bunches, long reel, a press 20in. long by 7½in. broad by 7in. by 17in. deep. For coarse lea three bundle bunches, and medium lea six bundle bunches, short reel, a press 12in. long by 8in. broad by 7in. by 17in. deep; for fine lea six bundle bunches, and very fine lea twelve bundle bunches, short reel, a press 12in. long by 7in. broad by 7in. by 15in. deep. The lesser depth is when the bottom is raised to its full height; the greater depth is when the bottom is lowered to its extreme limit.

Bunches.

The yarn should be put into these presses in the following manner: Let there be two hanks in each head of all long reel bunches up to three bundles, which in the case of a three bundle bunch would make 4 rows 6 deep = 24 heads and four half-hank ties, in all 50 hanks; four hanks in each head of all long reel six bundle bunches, making 4 rows 6 deep = 24 heads and four hanks for tieing, in all 100 hanks; five hanks in each head of all long reel twelve bundle bunches, making 5 rows 8 deep = 40 heads and cord ties, in all 200 hanks; two half hanks = one hank in each head of all short reel three bundle bunches, making 7 rows 7 deep = 49 heads and one hank for ties, in all 50 hanks; four half hanks = two hanks in each head of all short reel six bundle bunches, making 7 rows 7 deep = 49 heads and two hanks for ties, in all 100 hanks; five half hanks = two and a half hanks in each head of all short reel twelve bundle bunches, making 8 rows 10 deep = 80 heads and cord ties, in all 200 hanks. All the presses to have four slips for ties, and to be supplied with false bottoms for packings.

Cost of Drying and Bundling.

There remains not much more to say on the subject of yarn drying and bunching, except that the workers in these two branches are generally paid by the piece. The drying costs about 6d. per 1,000 hanks, and the bundling more than double that amount, and on this scale the men can earn from 17s. to 25s. per week.

But in the author's opinion, if men can be had who can be depended upon, it is not the worst way to pay them so much per day; as in the careful spreading and shaking on the poles in the drying loft, and in the properly "pinning" the yarn before being headed on the horn in the bundling room, depends the show that yarn will make on being opened out of the bunch. Yarn could not get too much shaking, and does not get nearly enough in any case. What a wondrous improvement can be made upon hard, poor dirty yarn, by twisting it up between two sticks into a knot, called stringeing it, and then loosing it down and levelling and stretching it over the horn!! A sample can be made to look sixpence a bundle better by this treatment.

Yarn Test.

It is very difficult to arrive at a correct idea of the proportionate strength of yarns. The rule we have found to give most satisfactory results is to divide the numbers 13, 9, 7, by the square root of the lea, to find the average strength of warp, medium, weft, line yarns respectively, in lbs. and oz. (Avoirdupois). The length tested must bear a certain proportion to the fineness of lea, as, for instance, 30's lea may be tested on a length of, say, 30in., where 300's lea would be long enough at, say, 10in.

The marketable price for bundles of yarns is so variable that any range given must only be considered as showing the comparative proportion in the price of the different qualities and counts.

PART VI.

MECHANICAL DEPARTMENT.

CHAPTER XXII.

MECHANICS AND SUNDRIES.

Mechanic Shop.

We now come to discuss a part of our subject upon which so much has been written and said that there remains not much that is novel to say—the subject of "Mechanics and Engineering."

In every spinning mill there must be kept a staff of mechanics proportionate to the size and condition of the buildings and plant. Over the journeymen it is necessary to have a foreman mechanic of thorough practical knowledge and intelligence. This applies even to the smallest matters, as it is often in these that the capacity of a foreman is most severely tried. In small manufactories he has generally to act as engineer and millwright besides; whereas, if the place be large, the foreman mechanic will have plenty to do in keeping up the proper working of his extensive shop, leaving ample work remaining for a skilled engineer. A thoroughly-competent overseer should be capable of turning out any article, either in the turning or fitting line, in as good style as any journeyman in his shop. This makes him independent of and respected by those under him. He should also have an accurate knowledge of all the parts of any machine about the place, and be conversant with practical engineering.

This department cannot be efficiently conducted without system. "A place for everything and everything in its place" should be adopted as a motto, and there should be a duplicate of everything that is likely to require renewing, these multitudinous articles being so arranged as to be hunted up without trouble. The only satisfactory way to make this arrangement is to allocate different compartments or shelves to the different departments of the establishment, as for instance, one for the flax department, containing spare catches, brasses, levers, cams and cam wheels, stripper-rod ends, holder-screws and nuts, covers, etc. One for the preparing and carding department, containing spare yews, arbours, bevel wheels, rubbers, brasses, conductors, carriers, covers, sliver pulleys, brackets, pillars, studs, spring wires, levers, etc. One for the spinning department, containing spare stands, brasses, arbours, builder rods, thread plates, quadrants, builder pinions, studs, brackets, spring wires, levers, etc.; and lastly, there should also be arranged a well-selected assortment of all gearing that requires frequent renewing; as cylinder pinions, crown wheels, bottom roller pinions, screw wheels and back shaft bevels, and builder and spindle wheels and bevels, etc. There should be a lock-up for all brass, whether scrap or necks, steps, brasses, bell wheels, reelers' sockets, saddles, washers, arbour nuts, gearing, etc., as brass is valuable; also all taps and dies and files should be thus cared for. Each mechanic and apprentice should receive the necessary selection of files, and be expected to keep up the number. On a file being worn, the foreman should give a new one in exchange for it, and preserve the old ones as he would the new. These old ones can either be sold for from 9s. to 18s. per cwt., as scrap, or be re-cut for about half the first cost. Sometimes these old files are worked up into tools, but there are so few the particular shape required that it is better to prevent any old files from lying loosely about, and to keep a stock of rod and bar steel for drills, taps, chipping tools and cold chisels, and all tools generally.

It is a small concern which cannot supply constant work for a blacksmith, who can make these tools, weld broken boss rollers, slides, screws, fallers, builder rods, and such like; and forge arbours, bolts and nuts, studs, pickers, spindles, shafting, and in fact anything in the malleable iron or steel line. A complete mechanics' shop, besides the forge, will contain the requisite number of vices and lathes, arranged with due regard to good light; a drilling machine or vertical; grindstones; emery wheels or glazers' polisher, which is a stout, square, slow-revolving box, into which is put, along with some emery and oily patch, the screws, flyers, nuts, etc., to be polished; and a machine for fluting brass spinning frame rollers. This machine can also be arranged as a planing machine. If there is no planing machine, the spinning brass rollers requiring refluting must be sent out to the machinist, and will be refluted for about twopence per boss. Besides this there is also the expense of pinning, that is, the boring out of all flaws and blow-holes that may come to view, and filling up with brass rivets, at a cost of from one penny to threepence per pin, according to size.

Blacksmith.

Furnishings for Mechanic Shop.

If there be sufficient room, it is advisable to have the machines for fluting the spinning wood pressing rollers in the mechanics' shop, where they may be under the supervision of the foreman, and where the cutters can be sharpened by his own hand or by that of the fluting master. The diameter of these cutters gradually decreases from about six inches to four. The continual sharpening soon cuts away the tooth, so as to necessitate the cutters being turned up anew, but no matter how small it becomes there is no necessity for increasing its speed, as the same number of teeth still pass through the wood.

Cutters of Fluting Machines.

There is difference of opinion as to whether it is most desirable to drive the cutter up or down. Some say that where the roller is put into the head with the old and dirty flute still on it, it saves the edge of the cutter to drive it upwards, and so cause the teeth to enter from underneath the flute, preventing their being blunted by the greater or less amount of sand and dirt that is compressed into the surface of the boss. If these old flutes were first slid off, it is acknowledged that it is proper to drive the cutter downwards, which causes the flute to be cut more with the grain of the wood, producing in consequence the cleanest and most even boss.

The cutter should be driven about 4,000 or 5,000 revolutions per minute, and must be a good fit for its spindle, and true on and perfectly plumb to the centres. The spindle must also be a nice fit for its socket. The centres must be firm and steady, not given to slacken back, thus allowing the roller to drop slightly on one side and be unevenly fluted in consequence. Also, the slide must be firmly and evenly clewed up in the shears.

From these and previous remarks it may be gleaned that successful spinning depends largely upon the fluting machines being kept in thorough repair; the cutter sharp and unburred in the flute, and the working parts of the machine true and tight. Attention to these matters, combined with careful gauging on the part of the fluters, is the only means of procuring a correctly-fluted roller—so essential to a good spin.

Notwithstanding the obvious advantage of keeping the fluting machines together in charge of a fluting master, and under the eye of the foreman mechanic, in many places these machines, and also the flyer eye apparatus, are stuck in some corner of the spinning-room for which they work. This originates in the idea of having the boys near to their work, but results in less work being done, and that in worse style; and besides, offers an opportunity for an unlimited amount of skulking on the part of all persons thus inclined.

But to revert to "mechanics." It is surprising and interesting to note the facility and expedition with which all

The Mechanic.

operations connected with the various branches of engineering, machine making, and millwork generally, can now-a-days be accomplished. This is effected mainly by various machines ingeniously adapted to accomplish the end aimed at, with the minimum of manual labour and expense. However, notwithstanding this improvement in mechanism the expert journeyman need not tremble. Most of the machinesare so complicated and expensive as not to warrant any but the most extensive machinists adopting them, as they are remunerative only where they can be kept driving away at the particular class of article for which they are designed. It is the being able to undertake the fitting and putting together of anything, from a steam cock to a steam engine, that makes the experienced journeyman fitter so indispensable. It is the turner's practical skill that enables turning, boring, planing or slotting to any size, shape, or angle to be accomplished with accuracy and expedition in the well-furnished and well-adapted lathe.

So extensive is the range of knowledge, and so numerous are the near cuts in these two branches of mechanics, that men generally serve an apprenticeship to either branch, but not to both. It is only the very smartest men, with innate taste for their calling, that can undertake both branches as efficiently as the average journeyman that one to which he has served his apprenticeship. In fact, if a man be a first-rate turner and fitter combined, and at the same time has a fair knowledge of engineering, it is not at the vice or lathe he should be, but acting as foreman mechanic.

An apprenticeship of six years is usually served in the mechanics' shop, the boy commencing at from 4d. to 8d. per day for his first year, and getting an increase of from 2d. to 4d. per day for each succeeding year until the last of his apprenticeship, when if he have proved himself thoroughly expert and intelligent he may hope to be installed as journeyman at from 15s. to 20s. per week for a start.

Duplicate.

In every well-regulated shop, where the foreman's anxiety is to get through the work expeditiously and well, there will be kept a duplicate of every article that frequently requires repair, as stopping of machinery for the repair of the article might be necessary unless precautions were taken. As for example: spinning frame cylinders, quadrants, quadrant pinions, twist gearing, and studs, etc., etc. Besides having all such articles ready at hand, it is of vital importance to keep in stock a plentiful supply of bar and round iron; copper, brass, and iron wire of all gauges; zinc, brass, galvanised and iron sheets of several gauges; and steel rods of all sizes, shapes, and quality, for the making of the various tools. Out of the last commodity—steel—it is surprising how many different qualities and tempers are considered necessary to the carrying on of the different classes of work. For example, there can be procured from the different steel and file manufacturers qualities specially made for turning tools, cold chisels, smith's sates, beds and punches, cups or snaps, shear blades, rose bits, lathe cutters, cutters and boring bits, boiler-makers' drifts, taps, dies, hammers, mandrils, lathe spindles, piston rods, flax rollers, drift bolts, spindles, flyers, etc., etc. In exceptional cases even all these different classes of steel are not sufficient to make a selection from, as the following extract from the Belgian *Moniteur Industriel* will show: "An

Receipts.

engineer having a piece of very hard bronze of large diameter to turn in a lathe could not succeed in cutting it with tools of any kind or temper until he kept the tools constantly moistened with petroleum, when they cut with readiness. He says that by using a mixture of petroleum and spirits of turpentine, steel with a straw-coloured temper can be worked perfectly well." This extract tends to show the difficulties that have to be contended against in the turning up of exceptionally hard substances, and gives information of great moment

to the turner, as few of the latter know of any liquid for keeping the edge of the tool cool and keen to cut, except the old and homely one of water and black soap mixed.

Having introduced one receipt, we cannot do better than quote some others of moment from the most reliable sources. The *Engineer* of January, 1876, says that an "iron cement which is unaffected by red heat may be made from four parts by weight of iron filings, two parts clay, and one part fragments of an Hessian crucible, all reduced to the size of rapeseed, and worked into a stiff paste in a solution of saturated salt. A piece of fire-brick can be used instead of the Hessian crucible." The *American Manufacturer* says that "leather may be affixed to metal so that it will split before it can be torn off. The preparation is a quantity of nut-galls reduced to powder, dissolved in eight parts of distilled water, and after remaining six hours to be then filtered through a cloth. The decoction thus produced is applied to the leather. Take the same quantity of water as that used for the nut-galls, and place it in one part of glue (by weight), which is to be held in solution for twenty-four hours and then applied to the metal, which should first be roughened and heated. The leather is laid upon the metal and dried under pressure."

According to Grier, in his Pocket-dictionary, an excellent cement for steam engines is as follows :—"Take of sal-ammoniac two ounces, sublimed sulphur one ounce, and cast-iron filings or fine turnings one pound. Mix them in a mortar and keep the powder dry. When it is to be used mix it with twenty times its quantity of clean iron filings or turnings, and grind the whole in a mortar, then wet it with water until it becomes of a convenient consistence, when it is to be applied to the joint. After a time it becomes hard and strong as any other part of the metal." The same author says : "In joining the flanges of iron cylinders or pipes to withstand the action of boiling water and steam, great inconvenience is often felt by the workmen for want of a durable cement. The following will be found to answer : Boiled linseed oil, litharge, and white lead mixed up to a proper consistence, and applied to each side of a piece of flannel, linen, sheet lead, or even pasteboard, and then placed between the pieces before they are brought home, as it is called, or joined." The author here remarks that for small joints, indiarubber rings are used with success, and for large ones, pure flax rope (soft twist and plaited), steeped in melted tallow. This packing to be always kept tightly screwed up between the flanges. Another substance now in the market for a similar purpose is asbestos cement. We will again quote Grier for solders for various purposes :—

"For lead: Melt one part of block tin, and when in a state of fusion add two parts of lead. If a small quantity of this, when melted, is poured out upon the table, there will, if it be good, arise little bright stars upon it. Resin should be used with this solder.—For tin: Take four parts of pewter, one of tin, and one of bismuth, melt them together and run them into thin slips. Resin is also used with this solder.—For iron : Good tough brass, with a little borax."

Iron or steel articles can be superficially hardened by instilling carbon into their surfaces, this process commonly going under the appellation of case-hardening.

To case-harden articles, procure an iron box sufficiently large to receive with ease the largest of the articles ; so that they may be covered in between layers of any carbonaceous substance, as bones, leather, charcoal, horn, etc., etc. The whole to be fastened down with an iron lid, well luted round with red or fire clay, or any such substance, to keep in the gases. A little prussiate of potash or salt is sometimes added. The box is then covered up in a strong, bright fire, and on its becoming of a dull red heat the carbonising is proceeding. The length of time that it may thus remain

depends entirely upon the size of the box and its contents, the quantity of carbon released, and the depth to which it is desired that the articles should be case-hardened—say from three to eight hours; the articles to be then dipped, every facility for the prevention of buckling or warping being well studied. The case-hardening can be removed at pleasure, to allow of repairs or alterations, by heating the article in the fire and allowing it to slowly cool, without being dipped.

This "letting down" or annealing can also be practised upon hardened steel, as the following extract shows: "According to Dr. Ure, the common way of softening steel is to put it into an iron case, surrounded with a paste made of lime, ox gall, and a little nitre and water; then to expose the case to a slow fire, which is gradually increased to a considerable heat, and afterwards allowed to go out, when the steel is found to be quite soft." Although the common mode of tempering steel is immersion in cold soft water, on the bar having first been brought to the necessary degree of heat (ascertainable by its colour from the hardest, which is pale straw-yellow, to the softest, which is a pale greenish blue), in a clear bright fire, previously freed from the sulphurous gas common to bituminous coal, by being charred; yet there are many other modes of tempering, as exposure to currents of air, or metallic plates, mercury, oil or wax dipping, and such treatment as the following, extracted from Gill's "Technical Repository:" The celebrated files made by Raoule, of Paris, are stated to be so extremely hard that they will act upon or abrade most files of English manufacture. This peculiarity is supposed to be given by the following composition:—

Mutton suet, not rendered but chopped small	2lb.
Hogs' lard	2lb.
White arsenic, in powder	2lb.

These ingredients being put into an iron vessel with a cover fitted to it, must be boiled until all moisture is driven off." Again, in the same work we read that a most suitable liquid for dipping thin and elastic articles, as saws, springs, etc., is—

Spermaceti oil................................	20 gallons.
Beef suet, rendered	20lb.
Neatsfoot oil	1 gallon.
Pitch	1lb.
Black resin	3lb.

A receipt for the removal of rust from steel with least abrasion, is, to rub sweet oil well into the affected parts, thus leaving it for 48 hours, at the expiration of which time the article is to be well rubbed with finely pulverised unslacked lime.

If turned or polished iron, metal, or steel be exposed to damp, it is not an easy matter to prevent rust forming, unless by the simple treatment of dipping the articles thus to be protected in melted tallow. The coating that adheres to the surface soon dries on exposure to the air, and is a very effectual, cheap, speedily applied, and easily-removed barrier against wet. If the articles be too large to be dipped, they can either be smeared with a brush dipped in the melted tallow, or else coated with a mixture of tallow and white lead. Where the article is too delicate to be thus smeared, a dusting of dry unslacked lime or whiting is very beneficial. This remark applies especially to such articles as hackles, gills, and card clothing.

For useful tables relating to the cohesion, specific gravity, etc., of woods and metals, we refer the reader to Note 7, Appendix.

Files.

In a well-regulated mechanic shop it is all important to keep a stock of varied and well-selected files, by the best makers. Not only are these files a considerable item of expense

in themselves, but the accuracy and expedition with which the work is turned out depends much upon their being suitable, and perfectly free from bend or twist. Any person wishing to have an idea of the extent and the importance of file manufacture would do well to peruse the very interesting and instructive account given by Holtzapffel in his "Mechanical Manipulation." For us, let us recapitulate some of the names and classifications of files in daily manufacture in some of our leading manufactories—Flat, half-round, square, round, warding, entering, taper-cotter, horseshoe, flat, and half-round rasps, mill saws, taper-topping, three-square, hand equalling, parallel-cotter, pillar, needle, round-off, bone, pottance, round-edged flat, extra-thin flat, and flat and high-back half-round, lock, arch, riffler, tumbler, oval-saw, square, cant, taper-cross, bellied, three-square, slotting double-tongued mill saw, taper-topping, etc. When it is considered that of these different styles there are four different classes, as rough, and bastard, second cut, smooth, dead smooth; and that of each of these classes files from three to thirty inches in length can be procured, some faint idea can be formed of the extent of the file business.

Files can be re-cut so as greatly to resemble new ones, only of lighter build, for less than half their original cost, or in the case of heavy files at so much per lb. When they become so much worn as to appear valueless, those that are not used up as scraping tools, drifts, boring bits, turning tools, etc., will command as much as 9s. per cwt. as steel scrap.

Mechanics' Rates

We conclude this chapter by remarking that the increase in tradesmen's wages has been fully proportionate to that of any other class of hands during late years. For example :—

	1855.—Per day.	1865.—Per day.	1875.—Per day.	1884.—Per day.
Mechanics......	3s. 6d.	5s. 0d.	5s. 6d.	5s. 6d.
Carpenters	3s. 6d.	4s. 8d.	4s. 10d.	5s. 0d.

and not only this monetary increase per day, but in 1875 the working hours per week were only 56, against 60 hours in 1855 to 1865.

CHAPTER XXIII.

FRICTION AND LUBRICATION.

As previously remarked, careful and regular oiling is of much importance. The loss of time and waste made by heated bearings or journals, no matter whether occurring among the gearing, shafting, or the different machines, is of serious account. For instance, if an engine bearing or the "footstep" of an upright shaft becomes hot, it may be necessary to stop the whole concern for an indefinite period until the affected part be cooled down properly. However, with proper precautionary measures, constant supervision, and the timely application of specific cure to the affected part, this serious loss need not occur. The precautionary measures comprise, keeping the bearings on true lines, using every means for the exclusion of particles of dust, and adopting the best methods of lubrication. Constant supervision will imply the seeing that the channels of lubrication are properly fed and kept free from obstruction. Timely cure may be the loosening of a cap or collar, so as to give freedom for the momentary expansion, or the application of water or ice, etc., round the pedestal—if not so hot as to endanger the cracking of the brasses from rapid contraction—and the internal application of such matter as is most cooling and of an anti-friction nature.

Heated Bearings.

Foremost among these commodities is pure castor oil or sulphur, antimony and tallow mixed; or the antimony sprinkled on with oil of a weighty body, as neatsfoot, lard, olive, or castor oil itself. Where the journal is much cut up, the sprinkling on of lead filings or scrapings at the same time may be efficacious in producing a temporary skin or smooth surface.

Methods of Lubrication.

There are many methods of lubrication. One of the oldest and surest is the dipping one end of a worsted thread in a cup of oil, the other end hanging down over the journal. However, this siphoning by attraction is rather wasteful, as the dropping of the oil goes on whether the journal be revolving or not. Another simple and more economical method is Hick's slack ring. This is a ring of ordinary iron wire, bent slack round the end of the journal to be lubricated. There is a sort of groove cast in each side of the bearing, into which the oil flows. The ring is large enough to hang down into the oil, but not to touch the bottom of the groove. The revolving journal carries round the ring, thus drawing up sufficient oil with it to lubricate the rubbing surfaces, as the oil travels over the latter by attraction. Of course when the journal is at rest so is the ring, and therein is the saving.

Yet another method is the needle lubricator. This is an inverted glass bottle, fixed in the centre of the cap or cover of the journal. Through a wooden plug—a good fit for the neck—is bored a hole, which can be filled by a wire needle of very loose or fairly tight fit, according to the desired flow of oil. One end of the needle plays up and down on the surface of the journal, the other working in oil in the bottle. This lubricator is very good for all light and slow-running journals, and has the advantage of making its need for replenishing easily noticeable through the glass; but it has the disadvantage of being affected inversely to the requirements of the case—contrary to the properties claimed for it—as, on the journal heating, the needle expands, and thus diminishes the supply of oil. This renders its use

most dangerous where there are high rates of speed, as the journal may take fire before the apparently correct lubrication—judged from the oil to be seen —is found to be misleading. Endeavours have been made, by using metal of non-expansive quality, to obviate the evil complained of, but with only partial success. This lubricator can be applied to the ordinary covers of preparing machinery, and is a very suitable lubricator for such purpose, but is liable to be broken during the brushing of the frames.

These covers of preparing machinery journals should be covered inside with thick flannel screwed to the metal, so as not to drop out or be the means of introducing those foreign articles that it is designed to exclude. This flannel forms a receptacle for the surplus oil, which would otherwise flow to waste, and helps to keep out dust besides. Another and efficient method of preserving the journal is to fill in the space round it, and also the space in the cover, with tallow, which will not melt so long as the journal remains good. However, the tallow must be of the purest.

Defective Bearings.

Scored and heating journals, ascribed to careless and insufficient oiling, often arise from very different causes. If there be any impurities in the brass of which the seats are cast, or if to save material and workmanship the seats have been cast too neat a size for the journals which are to work in them, all the cracks and blowholes—which may be full of sand—are not thoroughly scraped away, and will soon commence an abrasion of the journal that time only increases. On this ground, emery in any shape or form should never be put near a brass bearing, but the smoothing process be performed by scraping.

One of the most prevalent impurities in machinery brass castings is the short stumps of steel pins, which are left—but never should be—in the old gill stocks that are melted as scrap. It is very difficult to separate these particles from the molten mass. The durable qualities of seats or bearings also depend much upon the proportions and quality of the compound in the alloy. Again, no matter how sound may be the bearings and journals, if the oil used for lubricating be not suitable it may be impossible to prevent undue friction and heating.

Oils.

It requires long practice for one to become an expert in judging the qualities and capabilities of the various oils manufactured. In fact, we may quote from the *Engineer* of November 10th, 1878, and say: "At the present moment so little is known generally concerning the performance of the different oils that the public are much at the mercy of the vendors of these oils, who can make almost any assertion they like without fear of contradiction." The vendors require to mix oils so as to produce samples of the best colour, body, and smell, at the lowest possible price, and the users require to be able to discriminate as to the lubricating power of these oils, and whether they become viscid or glutinous when in work, or run to waste in hot weather, or freeze to fat in cold weather. Of course science has been brought to bear on these points, and so we have testing machines that indicate to how many degrees of heat a certain amount of friction will raise a body in a given time, lubricated by a certain amount of a particular oil. Also machines for testing the fluidity and longevity, and for detecting the gelatinising acid, or salt that may be peculiar to each class of oil. There is a machine for detecting the "flash point" of oil, that is the degree of temperature at which it will ignite. Oils volatile below 120° Fahrenheit are very unsafe.

There has lately been introduced in the market an oil called "Engelbert's Lubricator," which if it really possess all the advantages claimed for it by the owner is certainly among the first of oils, both as regards its moderate cost and its efficiency. Its analysis by John J. Broadbent, consulting and analytical chemist and demonstrator of practical chemistry, Charing Cross

Hospital, as compared with tallow, is as follows: "I have made a careful analysis of the lubricant 'Engelbert's Lubricator,' and find that it is composed wholly of a mixture of pure hydrocarbons, not volatilising at a temperature below 600° Fahrenheit (therefore it cannot be decomposed by high-pressure steam), with a very slight trace of inorganic matter—·08 per cent. The specific gravity is ·880. This lubricant cannot clog machinery, for when a thin layer of it is spread upon a steel plate and exposed to the air of a moderately warm room for several days, no trace of gummy matter is found. No oxidation or spontaneous combustion took place when tow or cotton waste was saturated with the lubricant, and allowed to remain in a warm room for several weeks. When this lubricant is used for lubricating the pistons or other interior parts of a steam engine, and is then carried forward into the condenser and boiler, being a mixture of pure hydrocarbons, it will not saponify and combine with the salts present in the water, as do suet and animal or vegetable oils, which, being composed of oleic acid, etc., and glycerine, are capable of saponification. This lubricant, when injected into the cylinders of steam engines, instead of softening and honeycombing their surfaces, will have a tendency to case-harden them."

Another oil, something similar, is the anti-corrosive cylinder oil of E. H. Kellogg, New York. Both these oils claim to be superior for steam cylinder lubrication to any other lubricator, as instead of eating away or corroding the parts, as will tallow and most animal and vegetable oils, they claim to case-harden and smooth cylinders, piston rings, valves, etc., etc.

We here insert a test table by Professor Thurston on the coefficients of friction and endurance of lubricants, the rubbing parts going at a velocity of 750 feet per minute.

Name of Lubricant.	Pressure in Pounds.	Endurance in Minutes.	Temperature Fahrenheit.	Coefficient.
Sperm Oil (Winter)	8	111	230	0·13
	16	29	225	0·10
	48	9	195	0·08
Sperm Oil (Summer)	8	165	170	0·13
	16	33	215	0·11
	48	7	265	0·10
Lard Oil	8	77	175	0·16
	16	27	250	0·12
	48	11	260	0·07
Neatsfoot Oil	8	106	205	0·15
	16	31	275	0·10
	48	6	190	0·10
Olive Oil	8	83	170	0·13
	16	41	245	0·10
	48	14	240	0·06
Cotton-seed Oil	8	107	185	0·16
	16	45	275	0·12
	48	12	310	0·07
Palm Oil	8	49	195	0·17
	16	15	235	0·13
	48	9	295	0·07
Castor Oil	8	45	160	0·19
	16	35	180	0·11
	48	11	375	0·07
Fish Oil (Cod)	8	40	200	0·15
	16	14	175	0·12
	48	9	220	0·07
Crude Mineral Oil	8	129	105	0·10
	16	97	285	0·10
	48	5	270	0·10

Chemical analyses show that animal tallow consists chiefly of stearine, palmitine, oleine, the stearine predominating. Ox tallow contains 76 parts of stearine.

To smooth away the asperities of toothed gearing, grease of different sorts is used, which can be procured at so much per hundredweight, suitable either for wet or dry gearing. But most of these cheap compounds are in reality very dear, as, on account of the quantities of iron ore and other injurious matter which they contain, cutting up of the cogs is greatly accelerated. In every concern of fair proportions it is most economical and advisable to manufacture this grease on the premises, as in this way all the old and half-used tallow and grease, and the oil of drip pans, can be used up. A receipt for cog grease of fair average cost, and which will give the best results as regards anti-friction and preservative qualities, is : 40lb. of tallow, 5lb. of palm grease, and 3lb. of black soap, melted together, and then $\frac{1}{2}$lb. of best black lead, powdered, stirred in. The whole to be left to cool.

Cog Grease.

CHAPTER XXIV.

WOOD TURNING, ETC.

Wood Turning.

THE "wood turner's" business consists in selecting from the timber yard —which he keeps suitably stocked—the requisite wood for making the bosses of the preparing-room pressing rollers. Birch, elm, sycamore, mahogany, elder, baywood, boxwood, or alder, etc., etc., can be used for this purpose, the last being in general request. It is treated as follows: The alder is taken in logs, or, as they are called, "sticks," to the circular saw, and there "cross-cut" to the proper breadth of "face" of boss, according to the diameter of that particular portion of the stick. On a few being thus cut up, the bosses are roughly trimmed and then "paired." They are then bored in the lathe by means of an augur slightly smaller than the diameter of the arbour ends on which the bosses are to be pressed. At this stage it will not be amiss to let the bosses "get the air" for a few days.

Preparing Arbours.

There are two descriptions of arbours:—the "canted" axle, or plain octagonal end, which is compressed by means of a powerful screw into the smaller-sized round hole, where it easily clears a path for itself; and on account of its partaking so much of the style of a wedge can only be used in connection with bosses of fair and large body or breadth of soft impressible texture, in fact for frames of medium and coarse pitch of boss-working softwoods. The other style is the "nut and collar axle," being a collar pinned on each end of axle, the ends being fitted with a screw and washer nut. A pinhole is bored in the boss to allow the pin to enter and become a steadying point for the boss, whilst it is screwed up tight against the collar by means of the washer nut.

This axle is generally used where the pitch of frame is fine, not allowing of much body in boss, and therefore necessitating the use of hard wood, as boxwood, to be set-off against the extreme lightness of the boss (sometimes not more than ½in.), the collar and washer screw acting as stays. There being no collar and nut upon the canted axle causes the boss to be pressed on by screw power so that it may remain firm and true, under the great pressure brought to bear on the arbour.

Slack Bosses.

The friction engendered by the great pressure on the roller whilst in work produces heat, which, if the wood composing the bosses be not thoroughly seasoned, will cause them to shrink, and so become loose on the arbour, and consequently useless; if, indeed, the bosses do not split outright. Therefore, even if only to save himself trouble, without taking into account the saving of wood and of time and material in the preparing department, the wood turner must cut up nothing but the most thoroughly seasoned timber.

Timber Seasoning.

The points peculiar to the growth of, and to the seasoning of alder, may be briefly described as follows:—Alder grown in the open country and hedgerows is better wood than that grown in plantations, as it takes a much longer time to grow, and is in consequence much closer in the grain than if it is nourished in rich moist soil with abundant shelter, such as is usually about plantations, where it flourishes with extraordinary rapidity, being soft and open-grained in proportion.

The most serviceable size of wood ranges from 8in. to 18in. diameter at the middle of the stick, which means timber of from nine to thirty years' growth. The age of timber can be pretty closely conjectured by counting the number of rings in the grain of the wood on its being cross-cut, each ring representing one year. There can be no estimate of age from the size of the tree, for the reason already stated ; but old and close-grained wood may generally be distinguished by tapering much and being very rough-barked. Young quickly-grown trees are more of one thickness from the root up, and also more evenly barked. On being cut up, old slow-grown alder will be distinguishable by the rings being close together and bespeckled with a small black tick, which denotes its fine quality. Alder must be cut down when there is least sap in the stem—that is, during the wane of the moon in the months of October, November, and December, as the seasoning process is most expeditious and effective when the pores are closed against the juices. Trees cut down when the channels are open and full of sap turn out a soft open-grained wood, very liable to become "dazed"—that is impregnated with dry rot, which is the decaying of the juices in their cells. "Dazed" wood is soft or powdery. It shows itself in large stained rings or patches through the log, and cannot be mistaken for anything but unsound wood, even by the most inexperienced.

There are various methods of insuring the expulsion of all sap from seasonably felled trees, which is simply the seasoning of the wood. The simplest is to chip off portions of bark all round and over the tree after the branches have been lopped off, thus bleeding or destroying the vitality of the bark. The logs must then be piled butt upwards, and the other end resting upon a dry bed of stones or boards, for the purpose of allowing the seasoning to be carried on by the elements, the rains and dews passing into the log and driving the juices before them. After about three months' exposure, and when the spring sun begins to put forth his heat, the sap is fairly well dried out, and then it is time to hermetically seal the extremities, and to remove the timber to large and airy sheds. Too lengthened an exposure to the elements would only result in the tissue becoming rent or "split," thus rendering the wood nearly valueless. To facilitate the regular and proper seasoning of the timber in these sheds the ends must be kept free from damp, and the logs turned frequently during an interval of about two years, after which the timber should be capable of withstanding the extremes of heat and cold, damp and drought, without splitting. The exact duration of time necessary to bring timber to this state of perfection by this slow but decidedly best method of seasoning depends much upon circumstances, the chief being the girth of the timber. A speedier method of seasoning is to chain the logs in a running stream, with their butts against the flow. By this means in a few weeks' time the sap will be entirely expelled, and on the logs being then "barked" and piled in stacks, on a dry bottom, to get the full benefit of the weather, six or eight months' time should have them quite fit for use. However, it is only in country places, where the water supply is unlimited, that this expeditious treatment is admissible. Where the timber has been of necessity felled with the sap rising, the ends must not be hermetically sealed, but thickly covered with spongy or porous matter, as cow manure, fungus, etc., to allow of what remains of the sap being absorbed into it, and then evaporated. To show the immense quantity of sap in such timber, it may be remarked that when "green" there will be only about 30 cubic feet per ton weight of wood, where of "seasoned" there may be 45 cubic feet—the "green" being worth from 1s. to 1s. 6d. per foot, where the "seasoned" will command as much as 4s. per cubic foot in some cases.

The cubic contents of felled timber is generally taken as follows : Find the girth at the middle of the log, divide this girth by 4, square the

Timber Calculations.

number thus obtained, and multiply the length of the log by it, to find the solid contents. Thus, a log 17½ft. long by 33¼in. circumference or "girth" in the middle:

4)33·25in.
8·31
8·31
69·06
210in.=17½ft.
Cubic foot=1728·00)14502·60
8·4 cubic feet contents.

According to another authority, if the timber be "standing," the length is taken as high as the tree will measure 24in. in circumference. At half this height the measurement for the mean girth of the timber in the stem of the tree is taken. One-fourth this girth is assumed to be the side of the equivalent square area. The buyer has generally the option of choosing any spot between the butt end and the half height of the stem as the girthing place. All branches, as far as they measure 24in. in girth, are measured in with the tree as timber.

For square or four-sided timber, take half the sum of the breadth and depth in the middle of log, square this amount, and multiply the length by it. Thus, a log 23¼ft. long by 14½in. deep by 11¼in. broad:

11·50
11·25
2)25·75
12·87
12·87
165·64
279in. in 23¼ft.
Cubic foot=1728·00)46213·56
26·7 cubic feet contents.

According to a competent authority the composition of the various kinds of wood is as follows:—

	Wood.	Carbon.	Hydrogen.	Oxygen.	Nitrogen.	Ash.	
Timber Composition.	Beech.....	49·36	6·01	42·69	0·91	1·00	Per cent.
	Oak.......	49·64	5·92	41·16	1·29	1·97	
	Birch......	50·20	6·20	41·62	1·15	0·81	
	Poplar....	49·37	6·21	41·60	0·96	1·86	
	Willow....	49·96	5·96	39·56	0·96	3·37	
	Average..	49·70	6·06	41·30	1·05	1·89	= 99·91

For further particulars regarding various kinds of wood, we refer to Note 8, Appendix.

Besides the management of the timber stock and the keeping up of the preparing pressing rollers, the wood-turner should have spare time to

Bobbin Repairs. devote to such matters as the making and repairing of rove bobbings, spinning bobbins, skewers, washers, etc., and the turning of any patterns that may be required. For such work there must be extra pay, as, for example, 7s. 6d. per gross for rove bobbins, 1s. to 2s. per gross for spinning bobbins, 3s. to 4s. per gross for skewers, 1s. 6d. per gross for washers, etc.; and so much an hour for pattern-turning, all material being supplied to him.

Timber Yard. Every spinning mill besides having a timber shed large enough to contain from two four years' stock of timber, should also possess a timber horse for resting scantling against. This upright frame should be situated in some airy position near the carpenters' shop, and should be large enough to contain at least six months' stock of pitch and yellow pine, memel, spruce, deal, and such like soft woods that are in constant requisition.

Yellow pine is in greatest demand, as it is most suitable for doors, windows, benches, yarn-poles, spinning-frame troughs, etc., etc., it being less liable to warp, twist or open with the variations of temperature. For the troughs, slabs of various degrees of thickness are required, as 1½in. for the bottoms, 2in. for the ends, 1in. for the lids and creels, 1¾in. for the backs, and 2in. bevelled to ¾in. for the fronts, etc. If well-seasoned yellow pine of these sizes, and free from shakes, knots, and sapwood, be used in the construction of spinning troughs, and be put together with tongued and grooved joints, well bedded in white and red lead putty, and with brass, tinned, or galvanised screws, endless minor troubles and expense will be obviated. All the fittings, as bridges, rove-rod bearers, etc., should be of either wood or brass, and they and the trough should receive three or four coats of pure red-lead paint at least a fortnight before being put into use. Troughs got up in this style, and kept in good condition by being periodically taken down to an airy shed and well scraped before the old paint becomes dry and hard, and then left to dry out thoroughly for at least a week before receiving the fresh coats of paint, will last a life-time. Troughs got up of unseasoned stuff, iron fittings, and badly painted, may be useless from leakage in three years.

Spinning-frame Troughs.

Pitch-pine does well for dry even temperatures, and memel for moist and cool atmospheres, as spinning room window frames and sashes, and it answers well for cold-water immersion, as flood-gates, weirs, sluices, etc. Hardwoods, as boxwood, beach, mahogany, oak, etc., are not benefited by exposure to the weather, but season best under some dry and airy corner.

Torsion of Woods. We will conclude these remarks upon woods by giving the results of experiments made upon the torsion of woods by Professor Thurston, of the Stevens Institute of Technology—"Different kinds of pine and spruce, ash, walnut, red cedar, white oak, Spanish mahogany, hickory, locust, and chestnut being tested as to their twisting capacity, gave the following results:—White pine was least able to bear torsion, and hickory, of course, best; but white oak, after reaching its maximum, was tougher than all; while ash, long refusing to twist, would give up all resistance when once it was twisted to its point."

Spinning. *Painting.*—Reference has been made to the careful painting of the spinning-frame troughs, and we can with confidence recommend that similar treatment should be bestowed at every available opportunity on all woodwork and iron beams, columns, tie-rods, bonding-irons, and the entire system of steam, water, and gas pipings, as there is no better preservative than systematically and well applied oil paint. To be well applied the paint must be spread over a perfectly dry surface, and free from oil and dirt. To effect this in a

spinning mill it is necessary to wash all the parts to be painted, if possible, just before a lengthened stoppage of the works is to take place—say at Easter time, or before extensive repairs—so as to give these parts time to dry out, and then to apply the paint. The same remarks apply to white-washing, as in the case of either painting or white-washing, time and money are only wasted, and possibly irretrievable damage done to the buildings by coating damp or "sweating" surfaces.

Belting.

Belting.—This being a subject common to all departments of the spinning mill, the author has hitherto postponed its consideration. The belts should be closely looked after during meal hours, etc., to prevent as far as possible their breaking down during the hours of work. Leather belts are found to be most durable when put on with the hairy side to the drum, as the fleshy side can best bear the increased stretching to which the outside of the belt must of necessity be subjected. In addition to this the smooth side of the belt bites better with the polished surface of the drum and pulley, and so diminishes the likelihood of the belt slipping. In the case of smooth surfaces, the adhesion is great, the air being expelled.

Inferior leather belting may be known by its cracking on the surface on being doubled up tight, and by the lap of the splice and the length between each splice, being long and of varying thickness, say 8in. and $4\frac{1}{2}$ft. respectively. This denotes that the most has been taken out of the hide, by the shoulder, which is thin and uneven, being included. Oak-tanned butts made of the heart or solid part of the hide, and cut parallel with the spine, will make the most level and strong belting, with a length of not more than 4ft. between each splice. A recently-introduced and very durable belt is of giraffe hide. It is apparently clumsy, but wears splendidly.

None of the present patent beltings can be spliced and wrought down in the same manner as leather, and it is for this reason that leather, although costing as much as 3s. per pound, is generally believed to be the cheapest in the long run.

Cotton belting is much substituted for leather, and is certainly very strong and level running, as there is only the single joining, until it becomes frayed on its edges by the belt-fork. Cotton belting is impregnated with either paint or india-rubber to exclude moisture, and to solidify the material. But the preparation increases the chance of the belts slipping off the drums or pulleys when they are in work, on the latter becoming bedewed with moisture. It also renders the worn-out belting of no marketable value.

Belt Joinings.

In the joining together the ends of belts, holes, of course, require to be punched to admit the lace. These laces are known by the name of horny, green, white, or yellow hide, according to skin and quality, and are of any size, the most serviceable being $\frac{5}{16}$in. broad by 36in. long for 3in. belting and upwards of great strain, and $\frac{1}{4}$in. broad by 24in. long for 3in. belting and under of lighter strain. For these the best punch is T. Dixon's No. 6 oval, if procurable. On sewing and putting on the belts, it is of special importance to have the joints running with the direction of the belt, which will prevent their being ripped and torn, especially if the belt be crossed.

Besides lacing, there are various other ways of joining the ends of belts, as with screws, tacks, rivets, or belt fasteners. Of the latter, the simplest and best for leather, but not for composition beltings, is the plain, slightly-grooved iron shell with four rows of teeth on the concave side. The two ends of the belt to be joined are brought close together and hammered into the teeth of this fastener, two rows in each end. The shell being on the outside does not interfere with the driving side of the belt, as the teeth

seldom do more than penetrate the leather ; and if they do protrude they can be riveted. The strain of the ends on the teeth only tends to draw the leather deeper on the slightly inclined teeth. These fasteners, however, give best results with light belting not driven at great surface speed, and uncrossed. They do not oppose any inequality between the belt and the surface of the drum.

Another well-known fastener is Sonnenthal's patent belt screw, the advantages claimed for this being—"the screw cannot get loose or drop out ; they do not cut the belts ; an ordinary screw-driver will fasten them ; they give a very tight grip ; they make the soundest fastenings known." Another patent by the same is the safety belt shipper, for putting on the belts without danger to the operative. Belt shippers have hitherto been so inefficient as to be as far as possible dispensed with in the passing of the belt round the drum, the operative preferring to use his hand for the purpose, although this practice is both dangerous and illegal.

Even cement is sometimes used in the splicing of leather belts, as we learn from the following extract. "For cement for leather belts take of common glue and isinglass equal parts, and place in a glue-pot. Add water to cover the whole. Soak ten hours. Then bring the mixture to a boiling point and add pure tannin, till the whole becomes ropy or like the white of eggs. Apply warm. Buff off the grain of the leather where it is to be cemented ; rub the joint surfaces solidly together ; let it dry a few hours, and it is ready for use. If properly put together no rivets will be needed, as the cement is as strong as the leather." In large concerns it is advisable to keep a man for repairing the belts, renewing the splices, and lengthening the belts for the spinning rooms, so long as the leather remains sound ; and on its becoming hard and short in the grain to pass them on to the more genial atmosphere and lighter strain of the preparing room, etc. If the concern be too small to admit of this, the belts can be weighed out to any cobbler, who, on the laces being supplied gratis, will be amply remunerated on the receipt of from 2d. to 3d. per joint, according to breadth, for all well-pared and evenly-sewn splices. By thus carefully keeping leather belts in repair, they may be wrought out to foot lengths, and even then the old splicings and cuttings will command as much as 6d. per pound. As previously remarked, the application of resin and oil to the belting, to prevent its slipping, is objectionable. A writer in the *Polytechnische Notizblatt* recommends the application of good linseed oil varnish to leathern, hempen, or cotton driving bands when they are new, and its repetition every few months while they are in use. This not only tends to preserve them, but also prevents their either stretching or shrinking with variations of temperature, so that they never sit too tight or too slack when at work. When thus treated they remain quite as supple as unvarnished bands, and far less liable to slip.

Belt Repairs.

As new leather belts stretch more or less when put into work, it is economical to cut the new new belt about one per cent. shorter than the old, this deficiency to be made good by the insertion of an old piece, which can soon be taken out on the belt becoming too loose. This practice will at the same time do away with any excuse for attempting to put on a new belt too tight, than which nothing is more injurious to both the belt and the bearings.

New Belts.

For some very useful information about leather belts in general, and about the largest belt in the world in particular, we refer the reader to Note 9, Appendix, where will be found an extract taken from the *Textile Manufacturer*, Manchester.

Gearing.

Simple as this subject may at first sight appear, there is scarcely any one branch of mercantile mechanical science

which has received more consideration, upon which more has been written, and which has made more rapid strides towards perfection from the days of bar-toothed wheels or trunnions and wooden shafting and pedestals, not so long since, to the present time of mathematically proportioned gearing and accurately turned and well polished shafting of best wrought iron.

The resistance of each wheel and the torsion of each shaft can now be so accurately calculated, that there is no difficulty in finding the maximum power that can be evenly transmitted with the least size and weight of gearing and shafting, which, in the main, results in the procuring of the minimum indicated horse power.

This attention to detail is very apparent where a recently erected system of shafting and gearing for transmitting power is examined. It will then be noticed that the gearing and shafting nearest to the motive power is most massive; the wheels, lying, upright, and horizontal shafting from this point regularly decreasing in dimensions, and consequently power, as a proportionate amount of strain is deducted. Even the size of the cogs is matter for calculation, resulting in their being proportionate to the size of the wheel. A cog is a wooden tooth, in contradistinction to one made of iron, and the wheels adapted for receiving these cogs are called cog or mortice wheels, to distinguish them from the iron wheels of which the iron teeth are part and parcel. Excluding the flywheel, all the principal driving wheels are generally mortice, as it is found that when wood works into iron the motion transmitted is more even and not so jarring; besides the chance of a serious breakdown is greatly diminished, for if any unsurmountable obstruction occur the wooden teeth yield to the iron—which is called stripping—and this often prevents great destruction of property. It may be objected that these cogs are the cause of nearly all the smashes, as pieces chip off and get jammed, and thus are the origin of the stripping. This may be true enough where the wood has not been properly selected for the cogs, or where the cogs have not been properly formed, and afterwards properly supervised. Proper supervision implies the inspection of each individual cog, just after it has been cleaned and awaits greasing. To the practised ear a blow of the hammer on the tooth will reveal any split, decay, or looseness otherwise undiscernable, and such defect should be at once rectified. The selection of the wood for the cogs should be entrusted to a responsible millwright, who will select for the purpose nothing but the closest and finest-grained beech, hornbeam, hickory, plane tree, etc., thoroughly seasoned. This he cuts up into blocks of the desired size, and puts away for some months in some dry and airy corner, so that any inclination to split or warp may become fully developed before more time is expended on them. The sound blocks, when required, are taken to the circular saw, and are speedily cut down to the exact shape required with the aid of box-gauges, etc. The tenon of the cog now only requires cleaning up with the plane before it is ready to be driven into the mortice of the wheel. The cogs must not be driven home too tight or the rim of the wheel may be split. The use of one or more ply of linen smeared with red-lead paint and lapped round the tenon—a slack fit—will allow of the requisite tightness being gained, and the driving through of the tail-pin will complete the fastening of the cog. Now commences the scientific part of the business, which is the carving of the addendum of the block into the tooth proper. This must be of the true epicycloidal curve. The object is the shaping of the tooth so that it will for the longest possible period exert a force upon the opposing one, during each revolution of the wheels, or simply the finding of those lines above and below the pitch line, which will offer the greatest resistance with the minimum friction and wear and tear. The pitch line referred to is the plane circumference of the wheels in contact, supposing them to be driving by

friction only; but as friction does not impart sufficient and regular power there are heights and hollows (teeth) over and under this pitch line, to prevent slipping. The various rules and methods for finding the correct proportions and shape of teeth to work at any angle to each other, etc., will be found enumerated in any work treating on mechanics end engineering. In gearing, to reduce to a minimum the wear and tear, it is advisable to have a hunting tooth—that is, wheels with the number of teeth in each so proportioned as that the maximum number of revolutions may intervene between the coming in contact of any two particular teeth.

Pitch Line.

It is evident that to find the "pitch" of a toothed wheel the diameter of the wheel from centre to centre of opposite teeth (or from the bottom of one tooth to the top of that opposite) must form the divisor, the total number of teeth in the wheel being the dividend to find the number of the latter per inch of wheel diameter. The number of teeth per inch is the "pitch." For example, a wheel of 20in. diameter, containing 40 teeth is $40 \div 20 = 2$ teeth per inch pitch. Then it follows that to find the number of teeth that should be in a wheel of a certain pitch and diameter, the pitch multiplied by the diameter will give the number of teeth that wheel must contain. Thus, a 2 per inch pitch wheel of 20in. diameter will give 2×20in. $= 40$ teeth in wheel. It is important to have correctly-formed patterns off which to cast wheels, so that full allowance may be made for the contraction of the metal, etc. Wheels must not be cast off wheels, as this would result in incorrect pitching, which would increase the wear and tear and the uneven jarring driving of the machines to which they are applied.

Shafting.

In planning a spinning mill, care must be taken to have it as compact as circumstances will admit of, the main building to be of rectangular shape, and any required height. Attention to the latter point has the advantage of taking up less ground space, of economising heat, light, expense of building, and last, but certainly not least, the driving power. Economy in this latter is still further increased by the seat of power being as much as possible in the centre of the building, or at least contiguous to it. The distribution of power to the various stories or flats lessens the strain upon the upright shaft, so that it may with beneficial results be proportionately reduced in diameter at each succeeding storey. But although the thickness of the shaft be lessened, yet the size of the boss that is cast upon each length for the driving wheel to be keyed to, must not be reduced, as it is of great benefit to have the several driving wheels exactly similar. When this is so, one spare one—which should always be in readiness—is sufficient for renewals or in case breakdown. If there is no spare wheel—as is too often the case—and a breakdown occurs, it may take days to repair it, whereas if a spare wheel had been in readiness as many hours would have sufficed for the taking down of the disabled wheel, and the correct keying on of the new one. Besides, serious smashes are most likely to occur in the case of those very wheels that cannot be replaced, as any overhaul they may require is likely to be postponed until some set time when there shall be a lengthened stoppage of the works. This often results in the interval not being safely tided over.

Gearing Repairs.

Another advantage that arises from having the mortice wheels, where practicable, all one size, is, that the millwright can bring his templets, blocks, gauges, etc., to far greater accuracy, and thus insure better fitted wheels than if he had numerous sizes and pitches to attend to.

Of the "spur" wheel, the connecting link between the motive power and the shafting, there should also be a duplicate, as it is especially liable to go astray; and may thus become the means of stopping the whole establishment for even weeks, until a duplicate be obtained from, probably, a great distance.

The supporting and keeping in position of the various centres of gearing, and of the shafting, by means of pedestals, seats, hangers, and pillow-blocks, etc., etc., brings engineering skill and practical experience into full play, as this is a branch of mechanics about which many standard rules cannot be laid down. The reason is that so much depends upon circumstances peculiar to each establishment, as the strength of beams, columns, and walls, and the relative position of each to the main branch of the gearing. All that need be remarked on this subject is that by means of auxiliary "cross beams," stays, pedestals, wall boxes, etc., of the greatest lightness commensurate with the requisite strength, in connection with bevel gearing of any shape or angle, there is scarcely any position, angle, or corner in which gearing and shafting cannot be affixed by a competent engineer. The horizontal or driving shafts of each storey are generally carried close to the ceiling by the interposition of "hangers" suspended from the beams, or affixed to the columns. The "lining up" of the shafting is effected with the aid of the "plumb bob," whipcord line, "level," long and short "straight edges," and softwood packings. These packings are planed to the exact thickness and bevel, and tightly screwed in between all collateral iron surfaces, so as to cushion or deaden the jarring or vibrating motion transmitted through the shaft from the gearing.

Hangers.

Rope-Driving.—Gearing, in many localities, is rapidly being displaced by drum and belting, or by rope and grooved-pulley driving. We are aware of leather belts of six feet six inches in breadth, and capable of transmitting three hundred indicated horse-power each, being in use in not a few establishments. In one establishment, that of Messrs. Thomas Fleming & Co., West Grove Mill, Halifax, there are three of these monster belts driving the whole of the machinery requiring 850 horse-power.

Rope-Driving.

But rope-driving is in still greater favour, is indeed becoming quite general, not only in the United Kingdom, but also abroad. Ropes of one to two inches in diameter made of jute, hemp, cotton or manilla (especially the latter), well twisted and stretched and protected against damp, etc., are found to give a cheap, level and noiseless drive.

If the diameter of the pulleys and the number and breadth of the groves in these pulleys be proportional to the power to be transmitted, and the ropes well manufactured, and all of the same age and evenly spliced, this becomes a very desirable substitute for gearing. The chief desideratum is to have the grooves exactly similar in diameter and size, and the ropes of exactly the same thickness, and an easy fit for the grooves. These matters being attended to prevent undue stress or friction on any particular rope, to its speedy destruction, and likely to that of the new one substituted — from unavoidable difference in its thickness, and consequently in its surface speed.

Ventilation.—Thorough and effective ventilation of factories has hitherto been difficult of accomplishment without producing a more or less injurious effect on the material in the course of its manufacture.

Improved Ventilation.

As a feasible and inexpensive method of securing thorough ventilation, we would suggest that in new buildings the supporting columns be cast a little larger and with apertures in their cupola, through which all the vitiated air and impurities might be drawn and discharged at the summit of each tier of columns, with the assistance of a revolving screw ventilator, or some such contrivance.

The columns need not choke up with dust, as they could be periodically swept down, like so many chimneys, from the top into pits in the floor at the base of each tier, whence the dust could easily be removed.

Objections on the score of the spreading of fire through this channel are not more weighty than might be adduced against any trap door, staircase, or hoist. Rather, if we mistake not, this very arrangement of the columns might be made, without much expense, the principal, and one of the surest means of fire extinction—that is, if we can by any means bring ourselves to estimate the importance of giving this question of fire prevention our most serious consideration.

Fire Prevention.

Organisation.—Before bringing this chapter to a close, we desire to make a few remarks *re* mill-life and organisation. From dearly-bought experience we can affirm that the never-ending routine and hardship of work, the unceasing din of the machinery, combined with the injurious atmosphere in which the operative lives, become depressing and enervating, despite the utmost care for health. Where no attention is paid to health, life becomes a drudgery and weariness unspeakable, only made endurable to the majority by uncontrolled gratification of the fleshly lusts. The consequence is that the physique of the mill operative is fast degenerating, and is so marked in a large proportion of the rising generation as to be really appalling. No doubt many wise, but too generally fruitless, schemes have been set on foot for the amelioration of the condition of the working classes, as better houses, free parks, and amusement at nominal charges, etc. The difficulty is that the great proportion of those whom the philanthropic schemes are destined to benefit cannot be induced to avail themselves of them. Their moral tone is too depraved. They love darkness rather than light. One of the principal causes of the depravity is the filthy condition of the workers' persons, caused by their mode of life. This visible sign of degradation the majority have no means, or at least no easy means, of removing.

Organisation.

Now, if extensive employers of labour would recognise this great difficulty against which the operative has to fight, or rather under which he sinks, they from purely economical considerations, if none other, might see the advisibility of putting cleanliness within the reach of every man, woman, and child in their employment, by the erection of swimming baths inside their premises. The surplus exhaust water from the engine, allowed to flow into and through a basin, would, at nominal cost, keep up a temperature of clean water that the most fastidious or delicate need not fear to avail themselves of. For this the operatives should have nothing to pay, and they should be allowed to avail themselves of the invigorating bath as often as desired. Next to this most important boon should be that of the most approved and thorough system of ventilation in all departments. The ordinary means of the fan-lights in the windows they will not avail themselves of, from the chronic dread of draughts. Next in importance would be to drive all machinery as slow, not as fast, as it could be driven without loss, thus lessening noise, dust, heat, and laborious work. This we have previously demonstrated to be a saving instead of loss. At the present day there is an insane cry of "turn-off," which has likely more to do with the decline in trade than it is credited with. Last and most difficult, although successfully tried in some cotton mills in England, is the system of paying bonus or dividend to the operatives, according to the success of the establishment, or better still, progressive wages and ultimately pensions for steady and long service. If some practical men in our trade were to give their experience of the difference in the value of hands, sometimes to the extent of more than the entire wages paid them, this latter proposition would not be counted chimerical by even the most sceptical.

Aids to Health.

If, combined with these boons, were established firm but lenient codes of rules to be in no instance departed from; and if the comfort of the operatives

and the interest of the establishment were studied by supplying such necessaries as linen jackets and aprons to all working with flax, and knives, pickers, waterproof aprons, etc., to all spinning-room hands, at lowest possible cost, the moral tone and energy of the flax operatives would soon improve, resulting in long-lived, happy, and contented people. To be consistent, and for economy, mill dwelling-house accommodation should be abundant and kept in thorough repair, the rent at the lowest possible figure, and coals, etc., supplied at wholesale prices. Attendance at cooking schools should also be encouraged, as the married mill-reared female is woefully ignorant of housekeeping, to her husband's and her own discomfort and loss.

Garment Accommodation.

It is exceptional to find sufficient attention paid to the providing of accommodation for the operatives' garments. This is especially reprehensible on the part of the employer in the case of spinning-room hands, who, from the nature of their occupation, are compelled to put off most of their clothing during work, and consequently require more—where they generally have less—accommodation than any others in the establishment. They are generally compelled to hang up their garments against the damp walls and ironwork, about the windows and columns, or to leave them, boots included, on the top of or under the dirty spinning frames. Thus their clothes are soiled and damped, so as to emit a disagreeable smell when worn. Besides, these bundles of clothes obstruct the light and give the room a very untidy appearance. Every endeavour should be made to supply the proper and necessary accommodation, which in every department, except the spinning, could be easily and inexpensively accomplished. The only place in the spinning-room where the clothes could be kept comparatively free from all damp and dirt, without obstructing the light, is under the frames, between the cylinder and the floor, the plain open rack—the only thing that will not contract damp—to be high enough from the floor to allow of the latter being "swabbed."

Dining Rooms.

In most places with any pretension to size, it is found beneficial to provide complete cooking and dining apartments, male and female separate, and in some instances even smoking and reading-rooms are supplied for the men. Where such is the case the bringing of any article, as can, parcel, or basket, etc., into or out of the mill can be strictly prohibited, which reduces to a minimum all inducement to theft or the use of stimulants during working hours, and lessons the chance of boisterous and improper conduct during meal times, as all hands can then be turned out, and the mill doors locked.

Model Mill.

Since this work first appeared there have been many new mills erected in various parts of the world. Among others, one in Germany, the general organization of which has been so ably described by a writer to the *Textile Manufacturer*, Manchester, that we have great pleasure in producing same for the information of our readers. The extract will be found as Note 10, Appendix.

CHAPTER XXV.

THE BOILER.

We feel that we have nearly exhausted our subject—that we have said our say as regards flax and tow spinning. Yet are we tempted to offer a few observations on subjects that those in authority in this branch of manufactures should not be ignorant of, even though they pertain to the science of engineering. These are some of the points to be observed for the securing of the most effective and economical plant for the generation of the motive power of the establishment.

Let us commence by a consideration of the ways and means of procuring steam. Boilers for generating steam are of all shapes and sizes, and are constructed upon various principles according to circumstances; but the common cylindrical two-flued internally-fired boiler known as the Lancashire is that most commonly in use in spinning mills, and concerning which we will make a few remarks. The material out of which these Lancashire boilers are constructed is generally the best Thorneycroft or Staffordshire rolled plate, the plates being usually $7\frac{1}{2}$ft. long by $3\frac{1}{4}$ft. broad, by $\frac{7}{16}$in. thick, but procurable of nearly any size and thickness. The standard diameter for this style of boiler is 7ft., which allows of the requisite area of grate and steam and water space consistent with the strength of the shell and flues. The flues are now made 2ft. 9in. in diameter, and are constructed of a slightly less thickness of stuff than the shell of the boiler, but the front rings of the flue, where the fire impinges most, are of the best procurable iron, Low Moor or Bowling, as it is in this part that the capabilities of endurance of the boiler are usually most severely tested. Furnaces are now generally of $\frac{3}{8}$in. steel plate. We say that the flues are now generally made 2ft. 9in. diameter, the size formerly being 2ft. 8in., as this was the greatest size of flue that could be riveted in under the old manner of turning in the angle iron at the extremities of the boiler; whereas now, by the very simple expedient of turning out the angle iron and riveting on the ends of the boiler externally, there is the clear space of 7ft. internally, allowing of the admission of the larger flues without raising them any higher. This arrangement is found to work more economically. It does not interfere with the strength of the boiler, and it leaves the riveting more open to inspection and renewal.

Length of Boiler. The most advantageous length for a Lancashire boiler depends upon the pressure at which the steam is to be worked, and whether there be a fuel economiser attached. If there be no economiser, the longer the boiler is, consistent with strength, the better, say 30ft., for the more complete absorption of all heat that passes through the flues. In case there is an economiser, the utilisation of heat before it passes away from the boiler is not of much moment, as it will be arrested as it passes through the tubes of the economiser on its way to the chimney. In such case, the boiler being short, say 24ft., will not be disadvantageous, as the generation of steam is so much the more rapid, and the boiler will be undoubtedly stronger, and capable of being wrought at a higher pressure.

The economiser here referred to is a system of parallel upright tubes, built in over the main flue to the chimney. By the raising or otherwise

of dampers set across the main flue at each end of these economisers the contents of the flue, consisting of smoke and flame, can be directed around these pipes, which are full of water circulated by expansion, and carried down into the flue, to attached to chains suspended over pulleys turned by gearing, the tubes are then pass up the chimney. By an improved arrangement of iron scrapers scraped free from soot outside. The best fuel economisers of the day are on the Green principal, discharging the feed water into the boilers at over boiling point, saving over 20 per cent. in fuel. From 32 to 80 pipes per boiler is the proportionate size of economiser.

The Economiser.

For fuller particulars as regards these fuel economisers, we refer our readers to Note 11, Appendix, where will be found a very interesting extract from the *Textile Manufacturer*, of February, 1883.

Another simple and effectual method of economising the heat passing through the flues is, by the insertion of Galloway's conical tubes through the flues, behind the bridge. These are plain conical tubes of about 6in. diameter at the lower end by about 10in. at the upper, placed diagonally through the flues, one tube to each ring, or about every $3\frac{1}{2}$ft. To receive the full benefit of the heat these tubes are crossed in the flue, but not so much as to prevent the advance of the sweep, say at an angle of about 30° from the perpendicular. There may be from three to seven tubes in each flue, and their speciality consists in their being the medium whereby the colder water from below the level of the flues is quickly drawn into the tubes through the narrow bottom orifice, by the heat, and as speedily expelled through the larger upper orifice by its rapid expansion. Galloway's tubes at the same time strengthen the flues.

Boiler Tubes.

Boiler Flues (internal).

The flues, unless constructed with exceptional care as regards correctness of circle and quality of work and material, are the weak points of a boiler; from the fact that the pressure is external to their circumference, and consequently is a crushing, not tensile, strain. This being an especially severe test if the exact circle be departed from, as must more or less be the case from lapped joints, if nothing else. Again, the flues may be the cause of the boiler's weakness, from the fact that it is they which receive the first and most heat, causing their expansion before that of the shell of the boiler, which puts to severe test the ends of the boiler. The greater expansion of the flues than of the shell is counteracted by flanging two or three rings of the flues by turning out their ends and riveting them together, thus allowing of a little play at the base of the flange rings, for expansion. These rings can at the same time be made to act as stays.

Boiler Building.

Although it may seem an immense undertaking to construct one of these leviathan boilers—to cut, punch, bend, rivet, caulk, and seam the many plates and numberless rivets with which one is constructed—yet mechanical power has been so pressed into the trade of boilermaking as to greatly curtail manual labour. For instance, there are punching machines which can make perforations $1\frac{1}{2}$in. in diameter through iron $1\frac{3}{4}$in. thick, as if it were cardboard that were being punched; shearing machines that can cut iron plate 1in. in thickness with the greatest facility; rollers that can roll into tubes or bend double the stoutest iron plate, even to bending stuff 2in. thick by only 12in. long; steam hammers that can beat out strong iron, and machines for riveting as fast as the rivets can be heated. When these facts are considered it will no longer be matter for wonder that boilers of from 10 to 16 tons weight can be fitted together to within $\frac{1}{8}$in. of the required dimensions, each seam being as water-tight as if of the solid, the whole capable of withstanding great pressure. The punching, to which we have referred above, is the cutting out of holes in

the iron plates so that the latter may be overlapped, and then drawn together by heated iron pins—rivets—of the required length being passed into the holes, and while hot, riveted down firm and sound either by hammer or with die punch and hammer. This perforation of holes in the material considerably reduces its strength, some authorities say as much as one-half; or stuff bearing 60,000lb. strain to the square inch, on being perforated will become unable to stand more than 30,000., the latter figure being reduced to as low as 23,000lb., and even 20,000lb., before the plates are properly brought together; as many of the holes have to be drifted or opened or drawn together by the insertion of a taper mandril, driven home with force. Thus punching is objectionable, from the fibre of the iron becoming torn or broken, and in some instances split right out. Consequently drilled holes and the discontinuance of the use of the drift are essential to the production of a really sound boiler.

Burned Plates. Fire should not strike against any plate on the other side of which there is not more or less water, as if the flame impinges on plates thus unprotected, the portion thus exposed to the heat will be "burned," which so materially lessens the strength of the boiler in that part as to endanger the whole. It is for this reason that the crowns of the flue should never be left with less than 3in. of water over them to prevent such an occurrence. The seams and joints being so much more remote from water than the plate itself, are much more likely to be affected by the heat. This cracks and burns them, causing lea kage and subsequently corrosion. Therefore in well-built boilers seams do not appear above the level of the grate surface in the front of the flue, and the construction of the shell should be regulated with similar regard to the position of the seams, so as to give the minimum exposure to the flame, and not hiding or embedding the seams in brickwork, so as to render the detection and righting of defects difficult.

Boiler Mid-Feathers. The brickwork or mid-feather on which the boiler rests should be of substantial brick-work walls, edged with fire-clay tiles made for the purpose; so that the boiler may rest upon not more than 2½in. breadth of feather along each side. The tiles and all other setting about a boiler should be bedded in fire-clay mortar, as any calcareous substance in contact with the iron is very destructive, causing corrosion, which in time calls for extensive repairs or causes a blow up. These walls also serve the purpose of separating the flues.

Boiler Flues (external). The direction of the draught in the boiler flues depends much upon taste. One method is to draw down the heat from the two internal flues at the back of the boiler into a large flue, of say 3ft. 6in. broad by 2ft. mean altitude, that runs under the boiler for its whole length. The contents of this flue are divided at the front of the boiler and carried along each side, these side flues being not less than 9in. wide where the swell of the boiler projects toward the side wall. These two draughts again meet at the back of the boiler, and are thence conducted into the main flue, or each side flue passes direct into the main flue. The size of the main flue depends upon the number of boilers feeding into it and thence up the chimney. By this arrangement of the flues the whole of the bottom of the boiler except the seatings, amounting to more than a semi-circle, is exposed to flame and heated gases. Another method is to draw the draught first down the side flues and then up underneath the boiler into the branch. Preference is generally given, however, to the former arrangement, as, the water being most difficult to heat as it lies in a mass in the bottom of the boiler, it is only reasonable to expose this portion to the liveliest

heat. For a still newer arrangement of flues, we refer to Note 12, Appendix, where will be read with interest an article from the *Textile Manufacturer* of March 1883.

Boiler Draught.

The draught can be increased or diminished in the flues by the use of the dampers, which can be raised or lowered at will so as to cut off communication between the boiler and the main flue, or the main flue and the chimney. The damper between the boiler and the main flue is always situated in the branch. If the natural draught be so bad—as often happens—as to render combustion too tardy for the generation of the requisite amount of steam, it can be augmented artificially. The space in front of the boilers should be open, to allow free circulation of air for good draught, which is greatly benefited by the chimney-stack—which should be high and of large area at both top and bottom inside—being at a considerable distance from the boilers. Of course the area of the chimney, as of the main flue, depends entirely upon the number of boilers and the sort of draught available. Where the latter is excessively bad notwithstanding, the only remedy irrespective of artificial means is to open up the grate-bar spaces ; to perforate the dead plate with holes ; and to close up all air-holes about the furnace doors. Where these remedies have to be adopted the best class of coal, and quite free from slack, can alone be used ; as otherwise quantities would drop through the bars, and the smoke would be excessive, it being unconsumed from want of air admitted through the furnace doors. Where the draught is excessively bad there is only one effectual remedy against the periodical scarcity of steam consequent upon change of coal, or direction of wind, etc. This remedy is to have plenty of boiler power, that is, a sufficient number of boilers to generate steam even with one constantly stopped for repairs or cleaning.

Boiler Power.

What is sufficient boiler power is merely a matter of calculation, made out for us by such eminent engineers as Fairbairn, Hopkinson, etc. Some of these we quote as follows : A fair boiler capacity is considered to be 5 square feet of effective section to one indicated horse power. In a two-flued boiler 30ft. by 7ft. the flues being 2ft. 8in. in diameter, the measurement will be as follows :

	Total heating surface.	Effective heating surface.
Internal flues	504	252
External flues	390	319
	894 square feet.	571 square feet

the grate area being 33 square feet. Hence there would be 27 square feet of total heating and 17 square feet of effective heating surface to 1 square foot of grate area. Therefore a common allowance of effective heating surface of boiler per nominal horse power of engine is 17 square feet per square foot of grate area.

The horse power of boilers is dependent in part on the capacity of the boiler itself, in part on the heating surface, and in part on the area of grate and the consumption of coal per hour. A common rule for estimating the horse power is as follows : Calculate the effective section of the boiler by adding to its diameter the diameter of any internal flues and multiplying this by the length of the boiler. Divide the product by the constant number 5·5, 5·75, or 6, according to the estimation of various engineers. From these rules it will be seen that the power depends upon the effective surface, and the latter upon the grate area, therefore the power is really dependent upon the area of grate.

The effectiveness of the grate depends as much upon the quality of coal, the draught, and the system of firing, as it does upon its area, therefore we would offer a few remarks upon the proper system of firing boilers. Too large a charge of coal causes quantities of smoke to be evolved, which tend to reduce the heat in the flues. The firing of both the flues, one after the other, has the same effect, and should be avoided by the fireman taking, say, the right-hand flues in stoking to the right and the left-hand flues in stoking to the left, as he passes along his range of boilers. The fire-bars should be kept clear and free from clinkers by frequent raking and careful drawing of the fires at such times as may be found most convenient, there being nothing which aids combustion so much as clear open bars.

Boiler Firing.

The different varieties of fire-bars, smoke consumers, and mechanical stokers, are far too numerous to mention. Suffice it that we refer the reader to Note 13, Appendix, where will be found extracts from the *Textile Manufacturer*, descriptive of some of the exhibits at the Smoke-abatement Exhibition held in Manchester in 1882.

Boiler Fittings.

Irrespective of the most recent improvements, economy of fuel depends much upon the condition in which the boiler is kept, whether free from sediment or scale inside and soot outside.

Boiler Cleaning.

Deposit in boilers is greater or less according to the nature of the water, whether off bog (organic) or mineral (inorganic) beds. The former is most desirable; as its sediment is loose and easily got rid of by frequently blowing through the boilers fed with this soft water, and by thoroughly scouring them out as often as every three weeks. With such water it may be desirable to open the mud-cock as often as three times a day, and the water-cocks of the glass gauge even every two hours, if the deposit be excessive.

It is no bad plan to test the water gauges even hourly, but when the water is of a hard or mineral nature, all these precautions will not avail to prevent a hard scale accumulating, in a wonderfully short space of time, on the surface of the flues and over the inside of the shell.

If no foreign substance be introduced to check the deposit of scale, there is no remedy but to get the inside of the boiler thoroughly chipped with hammers made for the purpose. This chipping is a very tedious operation, and may occupy a man as long as two months, or more a proportionately shorter period, before all the parts that can be got at are perfectly clean; without the skin of the iron having become much indented with rough usage of the, perhaps, too sharp edged chipping hammer. Unfortunately, the parts that cannot be got at, where the water has the least circulation, receive the largest portion of the deposit, and are sometimes coated as deep as one inch, or more, in scale.

Of course such a state of affairs occurs only in boilers that have been neglected, and where the growth of this evil has not been checked by the use of some simple and effective compound for preventing incrustation. The difficulty is that there are far too many of these incrustation preventtatives in the market—some highly injurious to both boiler plates and water, from the acids which they contain. Two of the simplest antidotes to incrustation are oak tannage and carbonate of soda, or soda-ash, mixed with the water in the boiler.

Even a greater non-conductor than scale is the sooty deposit that forms on the outside of a boiler and the inside of the flues. This should be thoroughly scraped off as frequently as may be necessary, which depends upon the draught and the class of coal, wood, etc., consumed. This smooth or sooty deposit is injurious in another way, as the following extract from the *Mechanic* will testify.

Boiler Sweeping.

"*Corrosion of Boilers by Smoke Deposits.*—When smoke deposits on boiler surfaces distant from the furnace are rendered moist by any accidental cause, the sulphurous acid in the gases of combustion determines the attack upon the metal by the formation of the sulphate of the oxide of iron. The attack can take place while the boiler is in use, or such of its metallic surfaces as may be wetted by leakage from the boiler itself, or by water infiltrated through the masonry, or derived from the condensation of the gaseous vapour with the gases of combustion by contact with surfaces relatively cold. It can also be produced while the boiler is out of use, by means of the humidity of the air in the flues. These different origins of the corrosive action point out the precautions to be taken for preventing its destructive effects. They only are those which should be adopted for the preservation of any apparatus, viz., careful construction, thorough cleaning, and maintenance in good repair,"

The above clearly points to the serious evil that may arise from careless treatment of boilers; and the reference to the damp soot being so injurious recalls to mind a not unimportant matter in connection with the supervision of boilers, which is, that if a boiler be leaking in some out-of-the-way place this need not go on longer than to the next time of careful sweeping out of the flues, when, on examination of the soot, there will be some portion of it discovered damp or with the appearance of its having been damp. On the other hand, dry soot is a proof of a sound boiler.

It is not only in the saving of fuel that plenty of boiler accommodation is of importance, but it is also necessary so as to allow of each boiler being regularly blown through and allowed to cool down gradually before the sweep is sent in, in order to give him a chance of doing his work honestly.

Rapid cooling-down of a boiler, by the putting in of cold water, is most injurious, from the rapid contraction of the plates opening up leakages.

Boiler Priming. There is no way in which insufficient boiler accommodation is more noticeable than in the increased tendency of overwrought boilers to prime. Priming means the intermixing of particles of water amongst the steam, which takes place on the removal of too large a quantity of steam at each stroke of the engines. This takes the pressure off the water in the boiler, and so allows it to boil too forcibly. Of course there are many other minor causes for priming, but all traceable to the above cause, or to the abnormal delay of ebullition, until the water bursts from control with increased violence. The chief risks to be dreaded from boilers priming are the driving away of water from the tops of the flues, and the passing of water along with the steam into the cylinder of the engine. According to a well-known authority, the steam room in a boiler should be not less than 12 cubic feet to 14 cubic feet for each indicated horse power. But even where there is plenty of steam room priming will often take place from ebullition being delayed by some oily or fatty substance coming in contact with the water and floating on the top of it. If, for example, the boiler be fed with unfiltered water from the engine condensor, some of the refuse tallow from the cylinder, so prevalent in the water, may cause the evil. Painting the inside of the boiler has been known to cause priming. Good and safe antidotes to priming from these causes may be found in the introduction of a very small piece of zinc, a little soda, etc., into the water in the boiler.

While referring to ebullition it may not be uninteresting to note some conclusions arrived at by the foremost experimenters on the subject. The boiling point of liquid varies with the pressure. Thus 212° is the boiling point when the pressure of the atmosphere equals 30in. of mercury, whereas, according to Professor Robinson, matter in perfect vacuum will boil at as low as 72°. Dr. Black, of Glasgow, tells us that all bodies have more or less heat in them which is insensible to the thermometer, hence

called latent heat. Experiment proves that it requires as much heat to change ice at 32° Fahrenheit into water as if we had added 140° Fahrenheit to the solid ice, were it capable of receiving this temperature without undergoing the molecular change of liquefaction, or what is the same thing, as much heat as would raise ice-cold water of the same weight to 172° Fahrenheit.

Boiler Effectiveness.

If the boiler be of proper construction and in good order, and the feed water passed in over 100° temperature, with the best coal, it is possible to evaporate as much as 12lb. of water with 1lb. of coal. Averages are as follows :—1lb. weight of coal, coke, slack, oak, and pine, will evaporate respectively 9lb., 10lb., 4lb., $4\frac{1}{2}$lb., and $2\frac{1}{2}$lb. of water. Again, it has been ascertained that the volume of steam at the boiling point into which one measure of water expands is 1,711, or in rough numbers, one cubic inch of water becomes one cubic foot of steam at 212°, consequently it becomes a mere matter of calculation to find the quantity of feed water of a certain temperature that is necessary for the generation of a sufficient quantity of steam of specified pressure to produce the indicated horse power requisite. Theoretically speaking it would be possible to derive one indicated horse power from 0·2lb. of coal per hour. Practically we expend often as much as 10lb. of coal per hour to procure one indicated horse-power when working non-condensingly, and as much as 4lb. with condenser. This shows what a vast percentage of force is wasted through friction, condensation, etc., and what scope yet remains for radical improvement in the design and construction of our boilers and engines. Year by year mechanical and scientific ingenuity combined are slowly but surely lessening this gulf between theory and practice, and now we find engines constructed that can produce the indicated horse power with as little as 1·7lb. per hour.

Boiler Coating.

This improvement in the economical working of engines and of boilers is traceable not to their improved construction alone, but it is also to a large extent due to extraneous causes, as boiler covering, steam jacketing, surface polishing, painting, etc., small matters to which too close attention cannot be paid. For the covering of boilers there are many materials used, with varying success, as hair felt, cow hair and road sweepings mixed, etc. To the last-mentioned, flax shoves and dust, saw dust, lias lime, or any other cheap non-conducting substance is sometimes added. These ingredients, when properly mixed and applied, form a coating decidedly preferable to such substances as hair felt, etc., which is of too inflammable a nature, and moreover does not act as a protection to the boiler. Thus, if—as often happens—a fire occur over the boilers, and the coating, if any, be burnt off, the plates become exposed to the full violence of the flames, and the burning fragment becomes red hot. If when they are in this condition water is cast on them, from firemen's hose, etc., they become bent and buckled, starting every joint and seam, and often rending with the violent contraction, which not only causes their destruction, but endangers life besides. In the special report of the Boston Manufacturers' Mutual Fire Insurance Company, is given the following receipt for a cheap and simple non-conducting covering for steam pipes, etc. :—Four parts coal ashes, sifted through a riddle of four meshes to the inch, one part calcined plaster, one part flour, one part fire clay. Mix the ashes and fire clay together to the thickness of thin mortar, in a mortar-trough ; mix the calcined plaster and flour together dry, and add to it the ashes and clay as you want to use it ; put it on the pipes in two coats, according to the size of the pipes. For a 6in. pipe, put the first coat about $1\frac{1}{4}$in. thick; the second coat should be about $\frac{1}{2}$in. thick. Afterwards, finish with hard finish, same as applied to plastering in a room. It takes the above about two hours and a half to set on a hot pipe.

This preparation when well mixed and applied in the form of a plaster or paste, in two or three coats of nearly an inch each in thickness, will soon harden without cracking, and become impervious to any ordinary abuse. It will not burn or drop off, as when properly proportioned the plaster is very adhesive to iron. This plaster coating has also the advantage of being non-corrosive, which cannot be said of many of the various boiler coatings, and, besides, it is a very speedy detector of any external leakage no matter how slight. A new and powerful non-conductor of heat has been discovered in slag wool, a fine fibre of silica produced by blowing steam through the slag of iron furnaces. This can either be applied in its pulpy state, by being sewn up in layers between old bales or sheets, and in this form wrapped round the surface to be protected from radiation, or else the slag wool can be procured woven into the form of coarse sacking ready for application. This substance will not burn. It is scarcely necessary to remark that not only should boilers be covered with some non-conducting substance, but also all steam piping, and the cylinders and the steam chests of the engines —in fact, wherever the radiation of heat can thus be counteracted.

As with steam piping for heating purposes, etc., it is often desirable to get the greatest radiation, we shall here enumerate the radiating and non-radiating properties of some well-known substances as given by an eminent experimentalist. The following is the radiating or emissive power of some different bodies, lamp-black, owing to its deficiency of polish, being taken as the standard of comparison, or of greatest radiating power, viz., lamp-black, 100 ; rough paper—white or black—98 ; glass, 90 ; china ink, 88 ; isinglass, 80 ; polished metals, 12.

Boiler Mountings.

But this highly to be commended system of coating all heated surfaces is only a small item in the multifarious matters that have to be attended to in the production of power with the minimum consumption of coal. There is to be considered—as before alluded to—the firing, cleaning, etc., and also the mounting of the boiler. The latter comprises the junction valve, the safety valve, the feed-water valve, the steam gauge, the blow-off taps and water cocks, etc. The the junction valve is that which connects the boiler with the main steam pipe. This valve will require to be well looked after, and the parts frequently overhauled to insure against sticking or derangement. Its seat also and the valve face will have to be brought up to a steam-tight bearing, by being ground in their bed with powdered flint glass or burned sand and water. This is preferable to emery powder, being more speedy in action and more easily cleaned from the bearings, on their being ground. Emery is liable to penetrate into the pores or interstices of the metal, and thus become a chronic source of wear. The safety valve is to emit steam if the latter rises above the prescribed pressure, thus preventing undue pressure on the boiler. This all-important valve has until of late not received sufficient attention, but frequent loss of life through the bursting of the boiler —from the safety valve having been over-weighted or having become locked —has drawn the attention of the Legislature to the subject.

Boiler Valves.

So little were the full requirements of the safety valve understood that it was not unusual to find it connected with the main or junction valve, so that when the latter valve was shut down there was no possible means of exit for the superfluous steam. Of course there are many safety valves of improved make now in the market, but in the writer's opinion, foremost among these should be reckoned Hopkinson's Patent Compound Safety Valve, which is simplicity itself, possessing neither spindle, guide, lever, nor parts liable to adhere. The valve is also very sensitive to any deficiency of water in the boiler. It is simply a matter of calculation to arrive at the most desirable size of safety valve, and the leverage with which it must be weighted.

The feed valve requires to be of exact construction, to act with precision; and its position in boilers is also of moment, as the feed should be delivered into the boiler as near the surface of the water level as possible, so that if it be cold it may have become hot and well circulated before it has had time to descend to the bottom of the boiler. However, the feed water must not be thrown in upon the crown of the flues, as nothing could well be more dangerous. Feed water delivered into the boiler as hot as possible will go far to obviate many difficulties in working.

If the water level show in the glass tube of the water gauge affixed to the front of the boiler, the fireman naturally thinks there is no possibility of scarcity of water in the boiler, as the glass tube is about eight inches between its sockets, and is so set as to allow five inches of water to be over the crown of furnace so long as the water appears in the glass. Nor can the water in the boiler be too much to admit of sufficient steam room, so long as its level remains below the top of the glass tube. But for all this, the tubes do not afford an infallible test, as they are sometimes unreliable from being choked with mud, or otherwise out of order or affected by priming.

To prevent siphoning there should be a cut off connection on the feed-water pipe of each boiler, or the feed valve should be of such construction as to discharge but not to receive back the water. It has frequently happened that where there is not a check to each feed valve the greater pressure of steam in one or more of the boilers has thrown back an excess of water into those boilers that may have less pressure, thus seriously endangering those that are short of water. A preventive against risk of explosion from burnt plates etc., has been patented in the form of a fusible plug, fixed into the crown of the flue, which will melt at the high temperature caused by the lowering of the water below the crowns, thus letting the plug drop out, and instantly admitting the water to put out the fires. If these plugs become coated with scaly deposit they become unreliable—in fact, like everything else about a boiler, they require care and attention.

Boiler Damping.

If from scarcity of water, sudden stoppage of engines or some unforeseen cause, it is imperative to curb the pressure of steam in the boilers without going to the trouble of drawing the fires, the opening to the full of both furnace doors and dampers, will admit so much air about the boilers as to carry away the heat and lessen combustion. Closing dampers—often done through ignorance—will only confine the heated gases about the boiler, and quickly increase the pressure. If dampers are well fitted this is not the case, as their closing quickly damps the fire by their own gases. The steam pressure gauge generally in use is Bourdon's improved. These gauges are simplicity itself, being of hollow tube bent in a circular or scroll form, and hermetically sealed at the disconnected extremity. The steam acting within this tube straightens or extends it in proportion to the pressure. This movement is communicated to a needle fixed in the centre of a dial, by means of a small-toothed sector geared into a little pinion on the needle pivot. The force exerted by the steam is registered by the needle on a dial marked off with the graduated pounds per square inch.

Boiler Particulars

For extracts from a very able dissertation from the pen of the editor of the *Mechanical World* of September, 1884, upon the requirements and construction of the very newest and most approved type of land boiler, we refer the reader to Note 14, Appendix.

CHAPTER XXVI.

THE STEAM ENGINE.

The Steam Engine.

The history of the invention and construction of the steam engine has been too often treated of in works on this subject for us to feel justified in adding to the number even if we felt competent so to do. The writer purposes to treat of the subject only in such a way as may be useful to the intelligent mechanic who may aspire to qualify himself for undertaking the charge of the steam engine as well as the mechanic shop, in a concern of small extent.

The construction and style of land engines are so varied that it would be impossible to attempt to enter into the merits of each; so with a word or two only we will pass to points more relevant.

The Beam Engine.

The beam engine, or that arrangement by which the reciprocating rectilinear motion of a perpendicular "piston rod" is transmitted to one end of a strong iron "beam" oscillating from the centre, is that often in use. The other end of this rocking or "working beam" is connected with the pin of the "crank" by the "connecting rod." The "crank-pin" is affixed in the extremity of—and at right angle to—the crank. The crank is a powerful arm of iron exactly half the length of the stroke of the piston from the centre of its crank-pin to the centre of the shaft upon which its other extremity is keyed. This shaft is the "crank-shaft" and on it is keyed the balance or "fly"-wheel. Thus is the reciprocating motion of the piston-rod transmitted into the revolving motion of the fly-wheel.

The Horizontal Engine.

The "horizontal" engine differs from the "beam" in that the power is transmitted direct from the piston-head to the crank-pin. This arrangement is now very general, but labours under the disadvantage of being more likely to allow steam to pass between the cylinder and piston. However, careful lubrication and ring pistons tend to mitigate this evil, the latter being a vast improvement on the now obsolete method of "packing." The packing rings of these pistons have a three-fold action, viz. :—pressing outwards against the cylinder with an equal pressure on all parts of the circle, pressing upwards on a rectangular surface—instead of an angular surface as in other pistons ; also pressing downward in a similar manner.

Ring-Piston.

The Vacuum.

There is nothing of more moment than to prevent passage of steam between the piston and cylinder, as not only is this so much steam lost but it also tends to destroy the "vacuum." A very fair estimate of an engine working may be arrived at from consulting the vacuum. A perfect vacuum gives about 15lbs. per square inch, engines may be in such prime working order as to register 13lbs.

Properly set valve, engine passing no steam, and cool condensing water are the points on which a good vacuum depends. This of course is on the supposition that the parts of the engine, as the air and injection pumps, etc., etc., are well proportioned, and in good order.

The Indicator.

Watt, the father of engineering, invented a little instrument which will indicate on paper the position and working of the valves of the steam engine at the various points of the "stroke,"

and the vacuum and pressure as well. The immense importance of this "indicator" cannot be better described than in the inventor's own words: "What the stethoscope is to the physician the indicator is to the skilful engineer, revealing the secret workings of the inner system, and detecting minute derangements in parts obscurely situate."

This instrument may be described as a miniature cylinder and piston, with a spiral spring intervening. To the head of the piston is attached a very sensitive arm which is linked with a marker that can be brought to bear against the face of an upright revolving tube around which paper is lapped.

This tube is given motion to by being attached by a string to the radius bar of "cross head," or some other convenient reciprocating part of the engine to be "indicated." In the bottom of the tube is a coil spring which is tightened on the tube being brought round by the cord. The stress of the cord being removed, the uncoiling of the spring brings back the tube to its first position, thus giving to it the reciprocating motion desired at each revolution of the engine.

There are taps affixed in the top and bottom of every cylinder to which the inlet pipe of the indicator must be coupled. This connection should not be made until the taps have been blown through to insure against any impurity being passed into the indicator on steam being turned on to heat it up to the normal temperature of the cylinder of the engine. The indicator being now in readiness with the sheet of paper stretched in the clips around the rotating tube the steam must be turned off so that the now stationary pencil may be brought against the moving paper, thus inscribing a straight line of the same length as the tube travels circumferentially.

The line is the "atmostpheric line," or that point in cylinder where there is neither pressure of steam nor resistance removed by vacuum, but the influence of the air only, this being a pressure of less than 15lbs. per square inch on each side of the piston.

The steam being now turned on the indicator, its small piston will execute movements proportionate to the pressure of steam in the cylinder of engine. This motion is communicated to the sensitive pencil, which when placed gently against the rotating paper inscribes thereon a figure around the atmospheric line that marks to the minutest detail the internal action in the cylinder of engine.

The Valves.

Having such positive information the working of the valves can be supervised and regulated to take the most out of the steam, to arrange for the exhaust being opened in time to produce a good vacuum, to close soon enough to allow the little remaining steam in cylinder to cushion under the piston, and to arrange for the inlet to open so as to admit the maximum force of steam on the piston consistent with freedom from strain, and for its closing at the most approved point of "cut-off," so as to use up the steam by expansion during the remainder of the stroke.

Cut-off.

This expansion of steam in the cylinder is found to give the very best results both as regards saving of fuel and steady working of engine. Where there is sufficient motive power the "cut-off" in many instances is as soon as one-twelfth part of the stroke; however in many cases the requisite power cannot be produced with the "cut-off" at less than one-half the stroke. This results in great waste of steam. Along with every indicator is supplied dividing and pressure scales, and a set of spiral springs, tested and numbered to work with the latter. The point of importance in using these springs is to make use of that which is most suitable in conjunction with the particular pressure at which the steam is passed into the cylinder to be indicated, and on calculating the figure to make use of the particular

scale for which the spring used in procuring that diagram is fitted. The springs are marked or numbered so as to give the necessary information.

On the diagram being taken, the greater the number of equal divisions into which its length is divided, the greater will be the accuracy obtainable in calculating the average pressure (vacuum included) per square inch on piston during stroke. This is called the average of indication card.

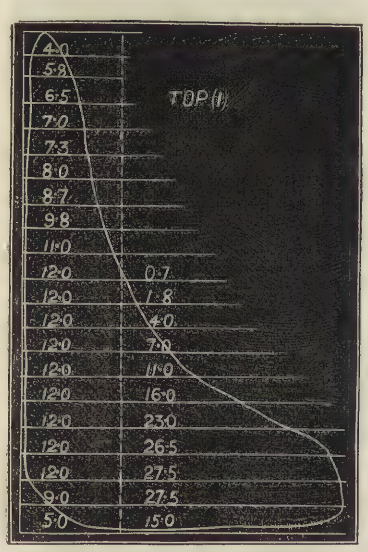
Calculation of Power.

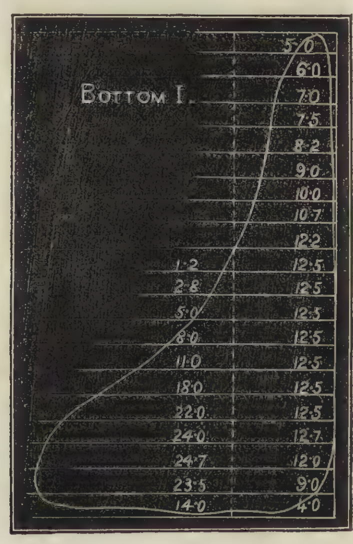
From this to calculate the power of engine:—The area of the piston must be multiplied by its travelling in feet, per minute, the result divided by 33,000, and the quotient multiplied by the average of indication card, to obtain the "indicated horse-power" that that figure represents.—"Indicated horse-power," because, according to Watt, 33,000 pounds weight raised one foot high, per minute, is a horse-power.

Indicator Diagrams.

This may be made clearer by placing before the reader a set of worked out diagrams of an admirable pair of condensing beam engines, by B. Hick and Son, of Bolton, of seventy-five horse-power each, nominal. Area of cylinder 46 inches; stroke, 7 feet; revolutions, 25 per minute. The line in red is zero, or the "atmospheric line."

PRESSURE AT BOILER 30LBS., SCALE 1-12TH.



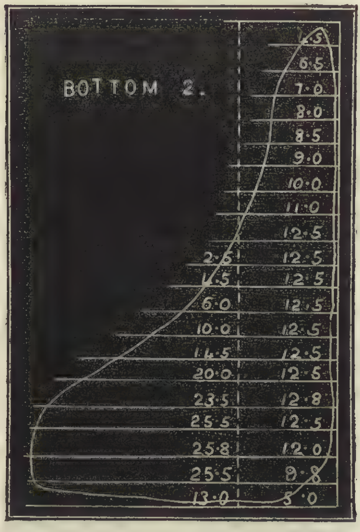


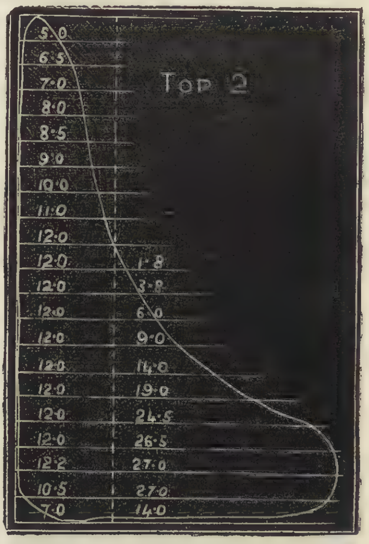
20)190·1	20)160·0	20)154·2	20)200·8
Avg. 9·50lbs. vac.	avg. 8·00lbs. pres.	avg. 7·71lbs. vac.	avg. 10·04lbs. pres.

2)35·25

Averaging 17·62lbs. Pressure in Cylinder.
46in. = 1661·9064 area × 350ft. ÷ 33·000lbs. = 17·62.
17·62 × 17·62 = 310·5 I. H. P. on Piston.

PRESSURE AT BOILER 30LBS., SCALE 1-12TH.—*Continued.*





20°)170·8	20°)204·1	20°)202·7	20°)172·6
Avg. 8·54lbs. vac.	avg. 10·20lbs. pres.	avg. 10·13lbs. vac.	avg. 8·63lbs. pres.

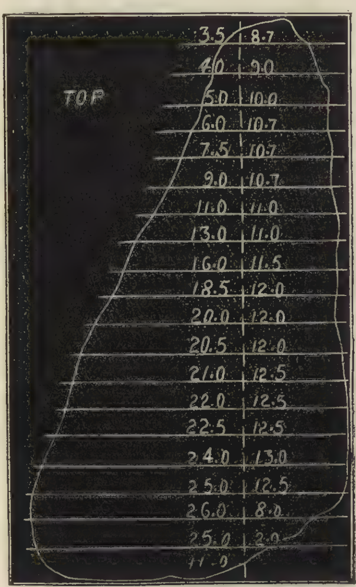
18·75 average pounds Pressure in Cylinder.
1762 × 18·75 = 330·4 I. H. P. on Piston.
310·5 I. H. P. on Piston.

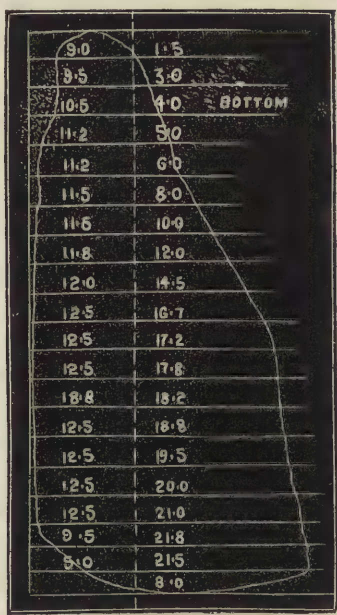
Total........641·0 I. H. P. on Engines.

In the diagrams it will be noticed that those taken from the top of the cylinder are a little larger than those off the bottom ; as the size of the figure denotes power, so long as there is no change of spring—the springs being tested, so that each inch of compression they undergo represents so many pounds pressure—as, $\frac{1}{10}$th, $\frac{1}{12}$th, $\frac{1}{15}$th, $\frac{1}{20}$th, $\frac{1}{30}$th, $\frac{1}{40}$th, etc., represent 10lb. 12lb. 15lb. 20lb. 30lb. 40lb. etc., per inch of figure to its height, *i.e.* perpendicular to the atmospheric line. It might be at first sight thought that the engine was unevenly pressed. However, this is not so, the explanation being that the vacuum is weakest when it is farthest from the condenser. But the steam gains buoyancy or expansive property nearly in proportion, so that what is lost in solidity of figure, is pretty well made up in its length.

Diagrams Compared. As a contrast to the perfection of the curves of those figures which tell of mud vacuum, judicious cushioning, and "level cut off," we give a pair of diagrams of a single beam condensing engine of thirty-five horse-power, nominal. Area of cylinder 32 inches ; stroke, 6 feet ; revolutions, 25 per minute, the contour of which cannot be regarded as illustrative of excellence in any of these points.

PRESSURE AT BOILER 30LBS. SCALE 1-12TH.





20")311·0	20")202·2	20")213·0	20")264·5
Avg. 15.55lbs. vac.	avg. 10·11lbs. pres.	avg. 10·65lbs. vac.	avg. 13·22lbs. pres.

Averaging 24·76lbs. Pressure in Cylinder.
32in. = 804·2496 area × 300ft. ÷ 33.000lbs. = 7·31 I. H. P. per lb.
7·31 × 24·76 = 181 I. H. P. on Engine.

Besides other defects, these two diagrams show a lamentable loss of pressure between the boilers and the cylinder, 30lbs. at boiler, and 26lbs. the height in cylinder. This is due to defective piping and valve arrangement, and the absence of steam jacketing. The critical test as to the general efficiency of boilers and engines is the number of pounds weight of coal consumed per indicated horse-power, per hour. The double condensing engines mentioned required 65 tons per week, of 56 hours, which is,

641 IHP.	2240 lbs. one ton.
56 hours.	65 tons.
35896)	145600 lbs. per week.
	4·06 lbs. per IHP., per hour.

The single engine required 25 tons per week, of 56 hours, which is,

181 IHP.	2240 lbs. one ton.
56 hours.	25 tons.
10136)	56,000 lbs. per week.
	5·52 lbs. per IHP. per hour,

or a saving of twenty-six per cent. in favour of the large engines.

There are various methods of finding the area of the piston, about the most expeditious being to square the diameter, and multiply by 0·7854, the result being the area in square inches.

Horse-power.

The nominal horse-power (HP.) of an engine is a very variable quantity, which arises from greatly increased speed of

piston and increased pressure per square inch of steam, since the days of Watt. He estimated a horse-power to be 33,000lbs. raised one foot high per minute, with an available pressure of 7 lbs. per square inch, and piston travelling 220 feet per minute.

For condensing engines it is pretty generally understood that there should be 22 square inch of piston area to each nominal horse power. The indicated horse power will depend entirely upon the working and superiority of build of the engine, some engines being perfectly safe and steady when indicating six times their nominal horse power, others unsafe at four times that amount.

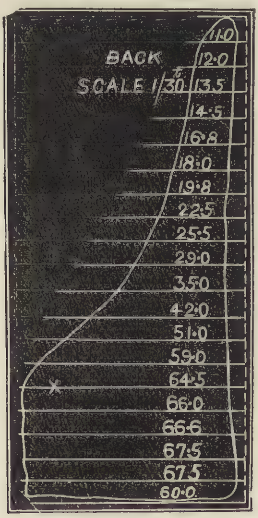
Heat in 1lb. of coal.

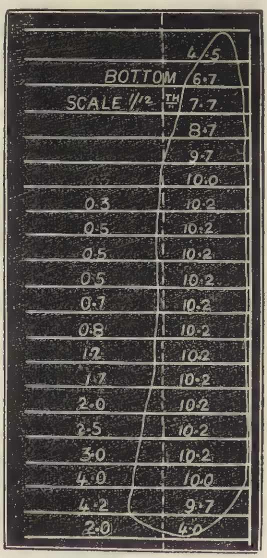
From scientific experiments by Faure and others it has been proved that 14,000 to 15,000 units of heat—of 772 foot pounds each—is liberated by the thorough combustion of one pound of coal. Consequently, theoretically, one pound of coal will be sufficient for the development of about five indicated horse power.

The calculations above given of the practical working of steam engines differ very materially from this possibility, and point to the fact of their being still room for not a little improvement in the construction and working of our boilers and engines. The greatest results yet produced in the engineering world do not reduce the consumption of coal per I. H. P. per hour below $1\frac{1}{4}$lb., with the most approved compound condensing engine.

Compound Engines.

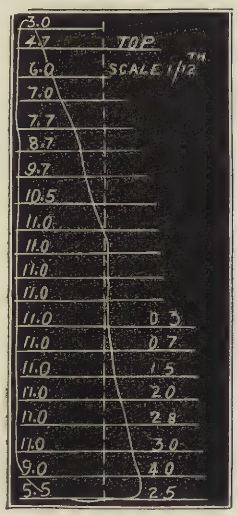
We give diagrams of a pair of compound beam and horizontal engines combined, of 16 HP. each :—

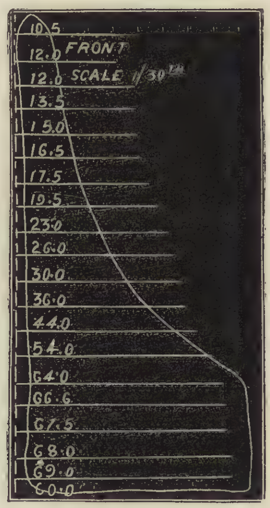




20°)761·7 — 38·08 20°)23·9 — 1·19 20°)133·2 — 9·06

High Pressure Cylinder (horizontal) 17in. diameter. Stroke $3\frac{1}{2}$ feet.
Low Pressure Cylinder (beam) 27in. diameter. Stroke $3\frac{1}{2}$ feet.
Revolutions 40 per minute.
Pressure at Boiler 75lbs.
Averaging 37·15lbs. High Pressure in Cylinder.
17in. = 226·93 area × 230 feet ÷ 33,000lbs = 1·92 per lb. × 37·15lbs. = 71·3 I. H. P.
Averaging 10·10lbs. Low Pressure in cylinder.
27in. = 572·56 area × 230 feet ÷ 33,000lbs. = 486 per lb. × 10·10lbs. = 49·1 I. H. P.
71·3 × 49·1 = 120·4 I. H. P. on Engine.





20°)181·8 20°)17·4 20°)724·6

9·09 ·87 36·23

Engineering Emergencies.

The efficient engineer makes use of his sense of hearing in detecting faultiness in the working of the valves, lodgement of water in the cylinder, scarcity of injection water or its being above the normal temperature, etc. Of course the "indicator" is the true detector of such inward defects, but it is not always feasible to wait upon its diagnosis.

Two instances illustrative of the readiness of an astute engineer occur to our mind at the moment. Without any previous warning a very great noise or jerk, occurred one morning, at each revolution of the pair of beam condensing engines, diagrams of which we gave above. The engineer at once gave it as his opinion that one of the pistons had become loosened on the rod. The engines were stopped, the cylinder cover raised by jack and block power, and inside the space of two hours' time from the first crack it was made evident that the "bridge" in the piston had been eaten away with the acids off the lubricating matter, and that the loose cotters were all that prevented the piston from being blown up the rod, or the steam meeting it from below.

The writer concluded that this would necessitate a stoppage of weeks duration until another piston should arrive from the makers of the engine—Hick & Son. Not so thought the engineer, however. He proposed the cutting out of the defective part, and the insertion of a strong iron block in the hollow of the casting to act as temporary bridge.

This was done, the mechanics working all the day and the following night. By dinner time next day—or after a stoppage of some fifteen working hours, or twenty-nine altogether—the engines were started with apparently as strong a piston as ever, as the block was held as in a vice by being run in with lead, and the whole making a firm bed for the cotters.

The engine indicated such satisfactory working with the patched piston that it was allowed to remain in work until the following Easter—some

eight months—and when taken out to be replaced with a new one, was quite sound, with the exception that the lead packing had become a good deal honey-combed from the acids. The other instance, which occurred to the same engine, was a lifting of the "entablature" beam at each stroke, that threatened soon to bring down the whole engines. This was serious. The engineer at once divined from its appearance that the entablature had become detached from one of the columns, by the breaking of the tenon. The writer was afraid that the engines must needs be stopped now, and that perhaps for months, as the ordering of a new column, the taking out of the broken one, and the putting in of the new would necessitate the taking down of nearly the whole engines. This would result in immense loss, some 25,000 spindles and all accessories being kept moving by this single pair of engines, and giving employment to 1,000 hands.

The engineer knew the capabilities of his charge ; he did not stop them for even a moment, but he got the load tightened by the stoppage of some machinery. He then got a log of timber cut the required length, to form a stout stay between the pedestal of the "working beam" and the stout iron beam in the ceiling above.

However, so irresistible was the "lift" of the entablature at each stroke, that the storey above the stay sprung to such an extent as to prevent the working of the machinery adjacent.

The engineer at once proposed the removal of the machine immediately over the stay in each storey, and he there erected stout stays from flat to flat, until the engine ceased to lift seriously, when the weight of five storeys was brought to bear on it.

He then erected scaffolding around the cupola of the broken column, and set mechanics to bore out slots on each side, and another hole large enough to admit powerful bolts and nuts into the "core" of the column. These stout bolts were hooked inside the hollow in the entablature, whilst with cotters bearing on the slots in the column and passing through loops in the extremity of the bolts, the bolts were forced by the power of the wedge to draw the entablature "home" to the column. This piece of workmanship, which even the engineer himself only intended to be temporary, and which it was feared might be of no avail whatever from the bolts springing on the removal of the stays, was found, on being subjected to this test, to be so firm and admirable a job, that for years this patched column was confidently believed to be the strongest of the four, and continues so to this hour. In the performance of this feat the engines were not stopped so much as five minutes out of their ordinary running ; and from the neat manner in which the large hole was filled in with wood, and the iron cotters sawn off and filled up "flush" with the flats of the column, and the whole then repainted, the most experienced eye would be some time in finding out which of the columns is the one that had been disabled.

Speed Regulator. This same engineer applied to these powerful engines an exceedingly simple and effective "speed regulator,"—so effective that with it the speed of the engine could not vary any perceptible amount without the tendency to vary being at once checked. In fact the whole arrangement was brought to such a pitch of excellence that by the shifting of a weight of about two pounds along a lever arm of not more than two feet in length which, connected with the ball socket, the revolutions of the engine could be regulated from dead slow, through all the gradations, up to the fastest speed with the precision of clock-work ; that is, the speed of a motor of up to 800 I. H. P. was controlled to a nicety by a 2lb. weight.

APPENDIX

TO

THE PRACTICAL FLAX SPINNER.

APPENDIX.

NOTE I.

FLAX SPINNING ENTERPRISE IN BELFAST.

BELFAST, at one time the great centre of Ireland's cotton manufacture, has become, within the past half century, the headquarters of the linen trade. In 1830 the Messrs. Mulholland, as already stated in these columns, started flax spinning by machinery, and from that time to the present every passing year increased the power and influence of the local flaxen manufacturers. Twenty years after the advent of the flax- spinning enterprise in Ulster's capital, Ireland had 400,000 spindles in full play; in 1860 there were nearly 600,000 spindles; and now, at the close of 1883, there are in Ireland 870,000 spindles, three-fourths of which may be found in Belfast and its neighbourhood. The wonderful changes which have taken place in the value of mill-spun yarns within the past forty-two years present something like the marvellous in prices. In 1841 flax sold in Antrim, Down, and Tyrone at 4s. 3d. to 6s. 3d. for hand-scutched, and 5s. 6d. to 11s. the stone for milled. At that time 30's line wefts were moved at 6s. 6d., 60's at 5s. 6d., and 120's at 8s. the bundle. Tow wefts declined about 3d. a bundle; taking the rates for low numbers in January last, say for 20's 5s. 6d., which in March went down to 5s. 3d., and continued at the latter figure till the close of the year. 30's, 40's, and 50's, quoted twelve months ago at 4s. 6d., 4s., and 3s. 9d. the bundle respectively held the same rates at New Year's Day, 1884. The value of raw material did not vary to any great extent for the next dozen years, and the rates for yarns in 1853 were 30's, 5s. 9d.; 60's, 4s.; and 120's, 5s. the bundle. Very dull times followed the Crimean War, and again inaction marked manufacturing annals in 1861, but the cotton famine left flax far up in the ascendant, and prices both of yarns and linens went up rapidly in 1863. Ireland had upwards of 300,000 acres under flax in the following year, and farmers rejoiced in ample yield as well as equally good prices. In the September of that season prime mill-scutched flax sold at 6s. 6d. to 11s. the stone. Millowners in 1864 seemed almost too big for their boots, as yarns could hardly be had fast enough off the spindles to meet the exciting demand. Medium warps No. 30's sold at 11s, 9d. the bundle, and ordinary wefts of the same count 10s. the bundle. Number 80's warp figured at 7s. 9d., and wefts at 6s. 6d. the bundle—in one case a hundred per cent. above the rates ruling on the last day of December, 1883. Linen cloth of all sets from 10's to 16's made no less movement in the market at that period; in fact, it was no uncommon episode in the history of the trade to learn that in course of a single week one line of Ballymena's changed hands two or three times, in each case with a fair profit to the seller.

Power-loom production of linens is of a comparatively recent era in Belfast. There was only a very few steam shuttles at work there in 1850. Seven years afterwards there were 3,000 such machines in play; in 1870 the number had increased to 14,000; and we may now give the grand total at 22,000, taking round numbers. Our worthy neighbours who dwell on the sunny side of the Straits have 500,000 spindles and 22,000 looms in motion. Their operatives work seventy hours a week at considerably less wages than those earned by our factory employés who only labour fifty-six hours a week. And yet those Frenchmen who lay an import tax of 10 to 15 per cent. on all yarns spun in the United

Kingdom which may be landed on their shores, are permitted to send over the product of their mills, and compete with our capitalists without paying a single penny of duty.

Mr. Michael Andrews, the very efficient secretary of the Belfast Flax Supply Association, gave in his last report an exceedingly valuable sketch of the British and Continental trades, both in flax-spinning and the make of linens. England and Wales possess about 200,000 and Scotland 260,000 spindles. The former has 4,000 and the latter 16,750 looms connected with the flaxen manufacture. Germany owns 320,000 spindles and 8,500 power-looms; Belgium has 300,000 spindles and 4,800 power-looms, and Russia has 160,000 spindles and 3,000 power-looms. It will be observed from these details that Ireland—or, we should rather say, the province of Ulster—possesses much greater productive power as to flax-spinning than any other country of the world, and, except France, has the largest number of steam looms in motion.

During the wild excitement that prevailed in the Ulster flaxen spinning trade in 1865-66, and when the range of ordinary line wefts ran from 6s. to 7s. the bundle, several of the Belfast concerns were converted into limited companies at the handsome price of four pounds the spindle paid to sellers. Since then the value of such machinery has been much reduced. In course of the past autumn one of the finest fitted up concerns in the kingdom—that of the late Sir John Savage—was sold at very much under twenty shillings a spindle. Many of the limited companies do not pay any dividend to their shareholders, and the value of these investments has fallen considerably.

The York-street mill, still at the head of the trade with its stock, 11 paid up, sold some years ago so high as 34; at present the figure is 23. Brookfield shares, 25 paid, were current at 33 and now bring 15; Ulster stock, 15 paid, sell at five shillings a share! The Falls, Northern, Smithfield, and Ulster Companies have not paid dividends, while the others have yielded 6 to 8 per cent. on current prices. It must, however, be admitted that the year of grace 1883 has been one of the most unfavourable known for a long period. And yet, while mill and factory owners were working their spindles and looms under very trying circumstances, the operatives enjoyed full wages and regular employment. It would be well if the leaders of strikes—these Parnellites of manufacturing industry—could be brought to look on these facts in the spirit of commercial equity.—*Textile Trade Review.*

NOTE II.

PLANT FIBRES.

A Paper on this subject was recently read by Professor Burgerstein, before the Verein zur Verbreitung Naturwissens Shaftlicher Kenntnisse, in Vienna, an English abstract of which cannot fail to interest many of our readers. *(Textile Manufacturer).*

The number of plants affording textile fibres is considerable. Some 300 have been indicated, belonging to about 50 distinct families, but especially to the *Malvaceæ, Linaceæ,* and *Urticaceæ.* Not a few fibrous plants figure in the earliest agriculture of the human race, such as flax, of which the Egyptian mummy-cloths are woven. The culture of some fibrous plants has reached a position of prime national importance, as in the case of cotton in the United States. The majority of fibrous plants require a very warm climate for their development, and hence are to be found chiefly in the tropical and sub-tropical zones.

In order to be able to recognise a fibre, and to estimate its textile value, a knowledge of its characteristics is necessary. These may be grouped under three heads—morphological, physical, and chemical.

Morphological study is directed to discovering which tissue of the plant contains the fibre, and on this head all plants may be divided into three groups:

(*a*) Fibres consisting of single seed-hairs—cotton, and vegetable silk; (*b*) fibres forming a long thick-walled cellular tissue, situated between the wood and the bark of the plant, and constituting "bast"—flax, hemp, and jute; (*c*) fibrous bundles permeating the leaves—New Zealand Flax, Manilla hemp, and agave. The morphology is studied by the aid of the microscope, which not only shows to which group the fibre belongs but also reveals the history of its construction, the elements of its composition, its shape and size, and other characteristic details.

The physical examination of a fibre discloses its colour, gloss, strength, and hygroscopicity. The colour of most fibres is whitish, bordering on yellow, green, or grey. Other hues are of rare occurrence, and then usually characteristic—for example, the snow-whiteness of cottonised China grass, the yellowish-brown of Nankin cotton, the deep red-brown of piassava, the black of *Tillandsia* fibre. As regards lustre, all degrees are to be met with, from the complete dulness of *Sida* fibre to the silky gloss of vegetable silk. An important quality of a fibre, not only in its determination, but also in its valuation, is its hygroscopicity, or property of absorbing moisture. The annexed table will show a few examples of this property:—

Name of Fibre.	Water present in air-dry condition.	Maximum absorption of water in a steam-chest.
Esparto	0·95 per cent.	12·32 per cent.
Piassava	9·26 ,,	16·98 ,,
Tillandsia	9·00 ,,	20·50 ,,
Cotton	6·66 ,,	20·99 ,,
Fresh Jute	6·00 ,,	23·30 ,,
Manilla Hemp	12·50 ,,	40·00 ,,

As fibres are mostly sold by weight, their great hygroscopicity is a matter of obvious importance to the purchaser.

With regard to the chemical view of the subject, it is to be remarked that plant fibres consist either of pure cellulose or of a combination of cellulose with other substances, chief among which is lignose or woody fibre. To determine the composition is a simple matter. A fibre formed of pure cellulose will be (1) coloured blue by immersion, first in iodine solution, and then in sulphuric acid; (2) dissolved, or perhaps only held in suspension, by freshly-prepared ammonio-cupric oxide. A lignified fibre will be coloured yellowish to intense golden yellow by aniline sulphate, and cherry-red by treatment with phloroglucine, followed by muriatic (hydrochloric) acid. The determination of the presence or absence of lignose in a fibre is often necessary, not only as a means of distinguishing fibres which otherwise resemble each other, but because the lignifaction of the cell-walls implies a change in the physical qualities. Thus unlignified fibres are pliant, supple, and of great strength, while lignified fibres are fragile, brittle, and easily broken, but by decomposition of this lignose (usually effected in the bleaching process) can be rendered softer and more supple.

The second group of textile plants embraces those whose fibres are contained in bast bundles. The most important is flax, an annual herbaceous plant, with thin spindly root, and a stem usually about 10 inches to 20 inches high. It is one of the oldest known fibrous plants.

According to the researches of the best authorities, it appears that the shrouds of the Egyptian mummies are of flax, and not of cotton, as previously supposed. The ancient Greeks were also acquainted with flax, as evidenced by Homer's allusions to it. In Herodotus' day flax was brought from Egypt to Greece, and later on the fine linen of the former country was esteemed in Rome. Outside Egypt the culture of flax seems to have been carried on in Eastern Asia in very remote times. Now flax is grown most extensively in Europe, both for its oil-seeds and for its fibre. In the latter respect Belgium takes the first place among European flax-raising countries, producing not only the finest kinds of flax but

the greatest quantity of the fibre (2,500 to 3,000 tons yearly). In Austria, flax-culture is common in Bohemia, Silesia, Carinthia, and the Tyrol. Outside Europe the most important fibre-producing lands are Algeria, Egypt, Brazil, and Australia. In growing flax for its fibre, if superior fibre is aimed at, it is impossible to secure at the same time a perfect crop of seed, for while the seed was maturing the fibre would deteriorate in quality.

The culture of flax as a fibre-plant demands much care. The sowing takes place either in the spring (April) or summer (June). The harvest from July (for Spring flax) to September (for late flax). The season for gathering is known by the base of the stem commencing to turn yellow. The seed collected at this stage is quite available for the oil-press, but not for sowing. The uprooted stems are first "rippled," or drawn in bunches through the teeth of a fixed iron comb, by which the branches, leaves, and seed capsules are removed. The next process is "retting," the object of which is not only to separate the fibrous tissue from the outer membrane and the woody tissue, but also to break up the fibrous bundles into fine fibre. The cells of the stems are bound together by a substance which is insoluble in water, but by the retting a sort of decomposition is induced, by which the intercellular matter is rendered soluble. The retting process is variously performed by dew, cold or warm water, and steam. To extract the fibre from the retted straw is an operation requiring a series of machines that need no description here.

On the properties of the fibre the following observations may be made :—The length of commercial flax is 7 inches to 48 inches, and is very variable. The thickness partly depends upon the more or less complete decomposition of the bast by the retting process, and fluctuates between 45 and 620 millim. The colour is grey, greenish, or yellowish, according to the treatment; the best sorts have a light-blonde tint. In glossiness there are all grades, from the dull Egyptian to the bright Italian and Belgian sorts. As the most brilliant kinds consist of the most thoroughly isolated bast cells, glossiness is rightly considered an index of quality. By chemical treatment flax is not lignified, hence its suppleness and strength. The best hackled flax consists solely of bast cells. The bad sorts often contain fragments of the outer membrane and the woody bodies of the flax stem. In their normal state the bast cells are regular cylinders, with conical or blunt ends, $\frac{2}{3}$ inch to $1\frac{1}{3}$ inch long, with a maximum thickness of 15 to 17 millim, and so solid that the central tube appears under the microscope as a mere dark line. By the retting and other operations the cells are generally torn, their surface roughened, and traversed by dark parallel lines.

The number of commercial kinds of flax has become very large. The most important are :—(*a*) Irish belongs to the best sorts, and is characterised by light-blonde colour, great fineness and softness, medium length, and strength; (*b*), Belgian, also one of the best, of blonde or steel-grey colour, equalling the preceding in fineness, exceeding it in length, and employed in the finest hand-made fabrics; (*c*) Italian, remarkable for its strong silky lustre; (*d*) French, especially in Normandy, and (*e*) Dutch belong to the finest sorts. Fairly good kinds are : —(*f*) Bohemian and Silesian ; (*g*) Russian (exported in immense quantities, the best from Riga and St. Petersburg), (*h*) Königsberg and Dantzic, (*i*) Egyptian, the largest of all. The waste from the hackling is known as tow and codilla. Flax is spun both by hand and machinery. Machine-spinning has of late years assumed such proportions that hand-spinning, which was formerly an important industry, now scarcely survives. The chief application of flax is for textures. It bleaches admirably, the operation being performed on the woven fabric, and rarely on the yarn.

NOTE III.

Extract from the *Belfast News Letter*, 21st January, 1880.

In recent reviews of the linen trade considerable importance has been attached to the inadequate supply of the raw material, flax. By far the greater bulk of the fibre used by our spinners is home-grown ; and although producers of fine

yarns depend chiefly on Belgium and Holland for the flax which they require, yet in the Irish crop is found occasionally flax of the very best description, and for which a very high price is usually paid. Irish flax is said to possess a peculiar toughness which makes it especially suitable for spinning warp yarns; but very often, on the other hand, it is bad in colour, destitute of quality, and so short that when dressed the line is almost valueless. Amongst farmers generally knowledge on the subject of flax growing is of the most elementary kind, and scarcely any two are agreed either as to the land which will produce a good crop or fine fibre. With some the practice is always to sow flaxseed after two grain crops following upon a crop of potatoes or other green crop. With others the practice is to sow it on broken lea, and in the County Down flax is very generally sown on potatoe ground. As to which is best there are no ascertained facts recorded, as based on experience. Even chemico-agricultural science has failed to demonstrate the kind of ground and the course of tillage which will with certainty produce either an abundant crop or good flax. Then, as to the choice of seed all is uncertainty. One man prefers Dutch, another prefers Riga, and another esteems both alike good; but there are few flax growers who can give any reason for their choice. We will take an illustration from the scenes of a market day in a country town in Ulster during the flaxseed season. A farmer, who has determined upon sowing a barrel of "Rago" (the common pronunciation for Riga), comes into the market, or fair, with his wife and some old man or woman—but most probably the former—who has a reputation in the district for being able to select good seed, and beginning at one end of the town they go round all the places or stands where seed is being sold, carrying from one to another a few pickles of each kind for comparison. As this is a tedious and tiresome business, the candid friend's judgment has not seldom to be cleared up and his strength invigorated by frequent libations, so that when the time arrives to purchase, and it cannot be delayed any longer, the samples have become hopelessly mixed, and the buying is done at the cheapest shop irrespective of quality. There are, however, flax growers who have always been accustomed to buy and sow MBM, D and V, or some other favourite brand of Dutch, and who depend more on the name of the shipper than on anything else, and these would not sow any other seed. Again in the Counties of Cavan and Monaghan very large quantities of English flaxseed are sown, and produce excellent fibre. American seed has also been tried, but has not succeeded in getting favourably placed. Even Professor Hodges, we think, could not tell whether Dutch seed or Riga seed is more suitable for sowing on a heavy clay land, on a light soil, or on land with a gravelly subsoil. With regard to the course of tillage necessary to provide a proper seed bed there is too much ignorance. A light winter ploughing, with the repetition of the same in spring, accompanied by cross ploughing and grubbing, is held by some to be essentially necessary; whilst in other cases the ground is scratched over with the plough and harrow, the seed harrowed in and rolled down, and the farmer who takes the least trouble is just as likely to have as good yield as his neighbour, who has gone to much more expense and trouble. Many persons hold that a deep soil is unsuitable for growing flax, and others are of a different opinion. With regard to wheat, oats, and potatoes, any farmer who knows anything of his business can tell where they must come in in the course of cropping, in order to produce average results. In the regular course no person would dream of sowing wheat after a crop of flax or oats, but there are no definite experiments recorded by which a flax-grower may be informed where in the series of crops flax should or should not be grown, as it has been tried at all stages. Notwithstanding the great value of a good home-grown flax crop to the staple trade of Ulster, and the necessity of information being widely distributed over the land, there is as yet no accurate source of instruction either as to the choice of ground, the kind of seed to sow, or the tillage necessary to produce a profitable outcome. Formerly there were Government instructors, but these have long since been dispensed with, and we do not know that their experiences have anywhere been collected or printed. As a rule, farmers do not note down for the use of posterity, or even for their own information, the facts which come under their observation year after year in regard to their husbandry. We do not know that the Flax Extension Association have as yet taken any steps

towards gathering into some connected form the results of experience in regard to the growing of flax. Statistics as to the exports and imports of flax, the acreage, average yield of the flax fields in Ireland, the number of spindles and looms at work, are very valuable; but all these do little to augment the supply of home-grown fibre, for which the spinner is so much in need, and without which the only important trade left to this country cannot be maintained. The present seems a favourable opportunity for increasing the growth of flax in the South and West of Ireland. America can furnish us with beef, mutton, pork, wheat, corn, flour, and fruit, but the United States and Canada combined cannot send us cargoes of flax. Ireland has a monopoly of this crop, and yet out of an acreage of twenty millions of arable land, we have only a flax crop of one hundred thousand acres. During last summer an attempt was made to originate a society for purchasing flax in the field and saving the seed, but like many other projects tried in Belfast for the benefit of our trade, it has come to nought. Unless something of this kind can be done, the large farmers of the South are not likely to undertake the labour and trouble of "growing a crop which they cannot bring to market. But the subject of flax-growing generally is one to which more attention should be given than it has yet received."

NOTE IV.

Recently, improvements in Flax Scutching machinery have been patented by Mr. James M'Kean, J.P., Castleblayney, Ireland. We take the following from the *Monaghan Argus:* —

The mill is built on a waterfall of 50 feet, and the motive power is a Leffel Turbine wheel, which Mr. M'Kean imported some years ago from America. The wheel is only 20in. in diameter; it runs at a velocity of 472 revolutions per minute, exerting a power equal to 70 horses. It may, perhaps, be not uninteresting to our general readers if we shortly detail the various processes through which the flax has to pass from the time it is received from the farmer until it is scutched or cleaned, and returned to him prepared for market. The first process is the softening of the flax by passing it through three deeply fluted rollers, placed horizontally one above the other, which break the cortex or woody matter within the fibre. These rollers, which are erected in the middle of the buildings, are those ordinarily in use in flax mills; but instead of their being placed on the floor, they are elevated so as to be more conveniently worked; and, moreover, the motion is reversed, the flax being fed between the middle and top ones, when it falls on the feed table to be reintroduced as before. These simple improvements reduce the labour so much that apparently a mere child could work for hours without over fatigue. The flax, when rolled or softened, is laid on tables to the right and left of the machine, whence the streakers, standing behind, take it, make it into streaks and pass them on to the scutchers in the usual manner. The next process is the scutching proper, which is intended to remove from the fibre all the broken cortex or woody matter, and leave the flax cleaned. The system adopted is precisely similar to that pursued in other mills, *i.e.*, the operatives work in pairs—a "buffer" and a "cleaner," and with the important exceptions of the soft quick stroke, and that there was an almost total absence of "stour" or dust, and an insignificant quantity of tow (which fell in front of the machine and not behind it as in other mills), we could observe no alterations in the machine until we examined it more closely when the machinery was stopped. We then saw no longer the heavy wooden handle of the old system, but in its place light steel blades were bolted to the rings or wheels, and so flexible are these steel blades that they yield under the slightest pressure. When the flax is held against these blades over the "stock," they strike it with a light, quick stroke, and apparently no matter how large a "streak" the scutcher may hold in his hand, the blade

yields, and does not injure or cut the flax away, but simply strikes off the cortex or woody matter. We also noticed that the striking edge of these blades was in a line, and hence none of the refuse was drawn behind the machine, so that instead of their being inches deep of what is called tow (but which is nothing more nor less than good flax pulled out of shape), coating the driving shaft, it was as clean as when it first started. Other improvements in the general working of the mill are not yet completed; but one now in course of construction deserves mention. Where the scutchers stand a sunk channel, to be covered by a perforated iron grating, is being made ; through the grating the shoves or wood off the flax will fall on to an endless belt, laid in the channel, which will carry them to a well or pit at the end of the mill. Any tow falling will be raked into an open trough running paralled to the sunk channel, and by means of another endless belt in this open trough, the tow will be carried to a tow shaking machine, to be placed almost over the refuse well or pit above referred to. The tow after being shaken will be discharged near to the door of the mill, while the refuse will fall into the well, whence it will be raised by elevators into a great hopper near to the roof. From this hopper all the refuse will be discharged by a trough through the wall of the mill into carts outside, which will convey it to the furnace. By these arrangements the mill is kept clear of all refuse and tow, and the state of the atmosphere cannot but be greatly affected thereby. It will be naturally asked what practical advantages are to be obtained from the adoption of Mr. Kean's patent. Careful experiments have been made, and an accurate comparison of the results produced by the old system of wooden handles and the new one of steel blades show the great intrinsic value of the invention. The trials prove that from samples of the same flax as much as 18 per cent. more of cleaned flax was obtained under the new system than the old—and the smallest increase was 11½ per cent. more. Scutched samples were numbered and submitted to a competent judge, who knew nothing about the manner in which the scutching had been effected, and those done by the new process were pronounced to be worth from 6d. to 8d. per stone more than those cleaned by the old process. As we have before said we believe that the general adoption of Mr. M'Kean's invention will establish that confidence between the farmer and the millowner which has hitherto been wanting, and with the view of further guarding their respective interests, Mr. M'Kean has drawn up a code of regulations for the management of his mill, which all millowners would do well to adopt. Mr. M'Kean is willing to show his new mill and process to any person interested therein, and is very desirous that both farmers and millowners should see the process in operation for themselves. In our opinion the improvement, which can be applied at a trifling cost to the existing mills, must be generally adopted in a short time, as it is of such immediate advantage to the flax grower, who will naturally patronize those mills which secure his flax being efficiently and economically scutched.

X.

FLAX TABLES.

Price per Stone and Fraction of Stone.

112lb.	14lb.	7lb.	6lb.	5lb.	4lb.	3lb.	2lb.	1lb.
s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
30 0	3 9	1 10½	1 7	1 4½	1 1	0 9½	0 6½	0 3¼
32 0	4 0	2 0	1 8½	1 5	1 2	0 10	0 7	0 3½
34 0	4 3	2 1½	1 10	1 6	1 2½	0 11	0 7¼	0 3½
36 0	4 6	2 3	1 11	1 7	1 3½	0 11½	0 7¾	0 3¾
38 0	4 9	2 4½	2 0½	1 8½	1 4	1 0	0 8	0 4
40 0	5 0	2 6	2 2	1 9½	1 5	1 1	0 8½	0 4¼
42 0	5 3	2 7½	2 3	1 10½	1 6	1 1½	0 9	0 4½
44 0	5 6	2 9	2 4	1 11½	1 7	1 2	0 9½	0 4¾
46 0	5 9	2 10½	2 5½	2 0½	1 8	1 3	0 10	0 5
48 0	6 0	3 0	2 7	2 1½	1 8½	1 3½	0 10¼	0 5
50 0	6 3	3 1½	2 8	2 2½	1 9½	1 4	0 10¾	0 5¼
52 0	6 6	3 3	2 9½	2 4	1 10	1 5	0 11	0 5½
54 0	6 9	3 4½	2 11	2 5	1 11	1 5½	0 11½	0 5¾
56 0	7 0	3 6	3 0	2 6	2 0	1 6	1 0	0 6
58 0	7 3	3 7½	3 1	2 7	2 1	1 6½	1 0½	0 6¼
60 0	7 6	3 9	3 2½	2 8	2 1½	1 7	1 1	0 6½
62 0	7 9	3 10½	3 4	2 9	2 2½	1 8	1 1¼	0 6½
64 0	8 0	4 0	3 5	2 10	2 3½	1 8½	1 1¾	0 6¾
66 0	8 3	4 1½	3 6½	2 11	2 4	1 9	1 2	0 7
68 0	8 6	4 3	3 8	3 0½	2 5	1 10	1 2½	0 7¼
70 0	8 9	4 4½	3 9	3 1½	2 6	1 10½	1 3	0 7½
72 0	9 0	4 6	3 10	3 2½	2 7	1 11	1 3½	0 7¾
74 0	9 3	4 7½	3 11½	3 4	2 8	2 0	1 3¾	0 8
76 0	9 6	4 9	4 1	3 5	2 8½	2 0½	1 4¼	0 8
78 0	9 9	4 10½	4 2	3 6	2 9½	2 1	1 4¾	0 8¼
80 0	10 0	5 0	4 3½	3 7	2 10	2 2	1 5	0 8½
82 0	10 3	5 1½	4 5	3 8	2 11	2 2½	1 5½	0 8¾
84 0	10 6	5 3	4 6	3 9	3 0	2 3	1 6	0 9
86 0	10 9	5 4½	4 7	3 10	3 1	2 3½	1 6½	0 9¼
88 0	11 0	5 6	4 8½	3 11	3 2	2 4	1 7	0 9½
90 0	11 3	5 7½	4 10	4 0	3 2½	2 5	1 7¼	0 9½
92 0	11 6	5 9	4 11	4 1	3 3½	2 5½	1 7½	0 9¾
94 0	11 9	5 10½	5 0½	4 2	3 4	2 6	1 8	0 10
96 0	12 0	6 0	5 2	4 3½	3 5	2 7	1 8½	0 10¼
98 0	12 3	6 1½	5 3	4 4½	3 6	2 7½	1 9	0 10½
100 0	12 6	6 3	5 4	4 5½	3 7	2 8	1 9½	0 10¾
102 0	12 9	6 4½	5 5½	4 6½	3 8	2 9	1 9¾	0 11
104 0	13 0	6 6	5 7	4 7½	3 8½	2 9½	1 10¼	0 11
106 0	13 3	6 7½	5 8	4 8½	3 9½	2 10½	1 10½	0 11¼
108 0	13 6	6 9	5 9½	4 10	3 10	2 11	1 11	0 11½
110 0	13 9	6 10½	5 11	4 11	3 11	2 11½	1 11½	0 11¾
112 0	14 0	7 0	6 0	5 0	4 0	3 0	2 0	1 0

IRISH.

Bought at Shillings per "Stone."

One Shilling = 12 pence.
One Stone = 14lb.
160 Stone = 1 Ton, nett.

Per Stone.	Per Ton.	Per Stone.	Per Ton.	Per Stone.	Per Ton.
s. d.	£ s. d.	s. d.	£ s. d.	s. d.	£ s. d.
3 9	30 0 0	5 7½	45 0 0	7 6	60 0 0
3 9½	30 6 8	5 8	45 6 8	7 6½	60 6 8
3 10	30 13 4	5 8½	45 13 4	7 7	60 13 4
3 10½	31 0 0	5 9	46 0 0	7 7½	61 0 0
3 11	31 6 8	5 9½	46 6 8	7 8	61 6 8
3 11½	31 13 4	5 10	46 13 4	7 8½	61 13 4
4 0	32 0 0	5 10½	47 0 0	7 9	62 0 0
4 0½	32 6 8	5 11	47 6 8	7 9½	62 6 8
4 1	32 13 4	5 11½	47 13 4	7 10	62 13 4
4 1½	33 0 0	6 0	48 0 0	7 10½	63 0 0
4 2	33 6 8	6 0½	48 6 8	7 11	63 6 8
4 2½	33 13 4	6 1	48 13 4	7 11½	63 13 4
4 3	34 0 0	6 1½	49 0 0	8 0	64 0 0
4 3½	34 6 8	6 2	49 6 8	8 0½	64 6 8
4 4	34 13 4	6 2½	49 13 4	8 1	64 13 4
4 4½	35 0 0	6 3	50 0 0	8 1½	65 0 0
4 5	35 6 8	6 3½	50 6 8	8 2	65 6 8
4 5½	35 13 4	6 4	50 13 4	8 2½	65 13 4
4 6	36 0 0	6 4½	51 0 0	8 3	66 0 0
4 6½	36 6 8	6 5	51 6 8	8 3½	66 6 8
4 7	36 13 4	6 5½	51 13 4	8 4	66 13 4
4 7½	37 0 0	6 6	52 0 0	8 4½	67 0 0
4 8	37 6 8	6 6½	52 6 8	8 5	67 6 8
4 8½	37 13 4	6 7	52 13 4	8 5½	67 13 4
4 9	38 0 0	6 7½	53 0 0	8 6	68 0 0
4 9½	38 6 8	6 8	53 6 8	8 6½	68 6 8
4 10	38 13 4	6 8½	53 13 4	8 7	68 13 4
4 10½	39 0 0	6 9	54 0 0	8 7½	69 0 0
4 11	39 6 8	6 9½	54 6 8	8 8	69 6 8
4 11½	39 13 4	6 10	54 13 4	8 8½	69 13 4
5 0	40 0 0	6 10½	55 0 0	8 9	70 0 0
5 0½	40 6 8	6 11	55 6 8	8 9½	70 6 8
5 1	40 13 4	6 11½	55 13 4	8 10	70 13 4
5 1½	41 0 0	7 0	56 0 0	8 10½	71 0 0
5 2	41 6 8	7 0½	56 6 8	8 11	71 6 8
5 2½	41 13 4	7 1	56 13 4	8 11½	71 13 4
5 3	42 0 0	7 1½	57 0 0	9 0	72 0 0
5 3½	42 6 8	7 2	57 6 8	9 0½	72 6 8
5 4	42 13 4	7 2½	57 13 4	9 1	72 13 4
5 4½	43 0 0	7 3	58 0 0	9 1½	73 0 0
5 5	43 6 8	7 3½	58 6 8	9 2	73 6 8
5 5½	43 13 4	7 4	58 13 4	9 2½	73 13 4
5 6	44 0 0	7 4½	59 0 0	9 3	74 0 0
5 6½	44 6 8	7 5	59 6 8	9 3½	74 6 8
5 7	44 13 4	7 5½	59 13 4	9 4	74 13 4

IRISH—*Continued.*

Per Stone.	Per Ton.	Per Stone.	Per Ton.	Per Stone.	Per Ton.
s. d.	£ s. d.	s. d.	£ s. d.	s. d.	£ s. d.
9 4½	75 0 0	10 11	87 6 8	12 6	100 0 0
9 5	75 6 8	10 11½	87 13 4	12 6½	100 6 8
9 5½	75 13 4	11 0	88 0 0	12 7	100 13 4
9 6	76 0 0	11 0½	88 6 8	12 7½	101 0 0
9 6½	76 6 8	11 1	88 13 4	12 8	101 6 8
9 7	76 13 4	11 1½	89 0 0	12 8½	101 13 4
9 7½	77 0 0	11 2	89 6 8	12 9	102 0 0
9 8	77 6 8	11 2½	89 13 4	12 9½	102 6 8
9 8½	77 13 4	11 3	90 0 0	12 10	102 13 4
9 9	78 0 0	11 3½	90 6 8	12 10½	103 0 0
9 9½	78 6 8	11 4	90 13 4	12 11	103 6 8
9 10	78 13 4	11 4½	91 0 0	12 11½	103 13 4
9 10½	79 0 0	11 5	91 6 8	13 0	104 0 0
9 11	79 6 8	11 5½	91 13 4	13 0½	104 6 8
9 11½	79 13 4	11 6	92 0 0	13 1	104 13 4
10 0	80 0 0	11 6½	92 6 8	13 1½	105 0 0
10 0½	80 6 8	11 7	92 13 4	13 2	105 6 8
10 1	80 13 4	11 7½	93 0 0	13 2½	105 13 4
10 1½	81 0 0	11 8	93 6 8	13 3	106 0 0
10 2	81 6 8	11 8½	93 13 4	13 3½	106 6 8
10 2½	81 13 4	11 9	94 0 0	13 4	106 13 4
10 3	82 0 0	11 9½	94 6 8	13 4½	107 0 0
10 3½	82 6 8	11 10	94 13 4	13 5	107 6 8
10 4	82 13 4	11 10½	95 0 0	13 5½	107 13 4
10 4½	83 0 0	11 11	95 6 8	13 6	108 0 0
10 5	83 6 8	11 11½	95 13 4	13 6½	108 6 8
10 5½	83 13 4	12 0	96 0 0	13 7	108 13 4
10 6	84 0 0	12 0½	96 6 8	13 7½	109 0 0
10 6½	84 6 8	12 1	96 13 4	13 8	109 6 8
10 7	84 13 4	12 1½	97 0 0	13 8½	109 13 4
10 7½	85 0 0	12 2	97 6 8	13 9	110 0 0
10 8	85 6 8	12 2½	97 13 4	13 9½	110 6 8
10 8½	85 13 4	12 3	98 0 0	13 10	110 13 4
10 9	86 0 0	12 3½	98 6 8	13 10½	111 0 0
10 9½	86 6 8	12 4	98 13 4	13 11	111 6 8
10 10	86 13 4	12 4½	99 0 0	13 11½	111 13 4
10 10½	87 0 0	12 5	99 6 8	14 0	112 0 0
		12 5½	99 13 4		

Rule.—For speedy calculation, multiply the "shillings per stone" by 8, and the answer will be the £ sterling per ton. Divide the £ sterling per ton by 8, and the answer will be the "shillings per stone."

NOTE V.

COURTRAI.

Price—Crowns per Sack.

A Crown = 5 francs 80 centimes,
A Sack = 41 bottes.
A Botte = 3lb. 1·7777oz.
720 Bottes = 1 Ton, nett.

Crowns.	£	s.	d.	Crowns.	£	s.	d.	Crowns.	£	s.	d.
8	32	11	10	24	97	15	10	40	162	19	6
8¼	33	12	2	24¼	98	16	2	40¼	163	19	10
8½	34	12	7	24½	99	16	7	40½	165	0	2
8¾	35	12	11	24¾	100	16	11	40¾	166	0	7
9	36	13	4	25	101	17	4	41	167	0	11
9¼	37	13	8	25¼	102	17	8	41¼	168	1	4
9½	38	14	1	25½	103	18	1	41½	169	1	8
9¾	39	14	5	25¾	104	18	5	41¾	170	2	0
10	40	14	10	26	105	18	10	42	171	2	5
10¼	41	15	2	26¼	106	19	2	42¼	172	2	9
10½	42	15	7	26½	107	19	7	42½	173	3	2
10¾	43	15	11	26¾	108	19	11	42¾	174	3	6
11	44	16	4	27	110	0	4	43	175	3	10
11¼	45	16	8	27¼	111	0	8	43¼	176	4	2
11½	46	17	1	27½	112	1	1	43½	177	4	7
11¾	47	17	5	27¾	113	1	5	43¾	178	4	11
12	48	17	10	28	114	1	8	44	179	5	3
12¼	49	18	2	28¼	115	2	1	44¼	180	5	8
12½	50	18	7	28½	116	2	6	44½	181	6	0
12¾	51	18	11	28¾	117	2	10	44¾	182	6	5
13	52	19	4	29	118	3	3	45	183	6	9
13¼	53	19	8	29¼	119	3	7	45¼	184	7	2
13½	55	0	1	29½	120	4	0	45½	185	7	6
13¾	56	0	5	29¾	121	4	4	45¾	186	7	10
14	57	0	10	30	122	4	9	46	187	8	3
14¼	58	1	2	30¼	123	5	2	46¼	188	8	8
14½	59	1	7	30½	124	5	6	46½	189	9	0
14¾	60	1	11	30¾	125	5	11	46¾	190	9	5
15	61	2	4	31	126	6	3	47	191	9	9
15¼	62	2	8	31¼	127	6	7	47¼	192	10	2
15½	63	3	1	31½	128	7	0	47½	193	10	6
15¾	64	3	5	31¾	129	7	4	47¾	194	10	10
16	65	3	10	32	130	7	9	48	195	11	3
16¼	66	4	2	32¼	131	8	2	48¼	196	11	7
16½	67	4	7	32½	132	8	6	48½	197	12	0
16¾	68	4	11	32¾	133	8	10	48¾	198	12	4
17	69	5	4	33	134	9	3	49	199	12	9
17¼	70	5	8	33¼	135	9	7	49¼	200	13	1
17½	71	6	1	33½	136	10	0	49½	201	13	6
17¾	72	6	5	33¾	137	10	4	49¾	202	13	10
18	73	6	10	34	138	10	9	50	203	14	3
18¼	74	7	2	34¼	139	11	2	50¼	204	14	7
18½	75	7	7	34½	140	11	6	50½	205	15	0
18¾	76	7	11	34¾	141	11	10	50¾	206	15	4
19	77	8	4	35	142	12	2	51	207	15	9
19¼	78	8	8	35¼	143	12	7	51¼	208	16	1
19½	79	9	1	35½	144	12	11	51½	209	16	6
19¾	80	9	5	35¾	145	13	3	51¾	210	16	10
20	81	9	10	36	146	13	7	52	211	17	2
20¼	82	10	2	36¼	147	14	0	52¼	212	17	7
20½	83	10	7	36½	148	14	4	52½	213	17	11
20¾	84	10	11	36¾	149	14	9	52¾	214	18	4
21	85	11	4	37	150	15	1	53	215	18	8
21¼	86	11	8	37¼	151	15	5	53¼	216	19	0
21½	87	12	1	37½	152	15	10	53½	217	19	5
21¾	88	12	5	37¾	153	16	2	53¾	218	19	9
22	89	12	10	38	154	16	7	54	220	0	2
22¼	90	13	2	38¼	155	16	11	54¼	221	0	6
22½	91	13	7	38½	156	17	3	54½	222	0	10
22¾	92	13	11	38¾	157	17	8	54¾	223	1	3
23	93	14	4	39	158	18	0	55	224	1	8
23¼	94	14	8	39¼	159	18	5	55¼	225	2	0
23½	95	15	1	39½	160	18	9	55½	226	2	5
23¾	96	15	5	39¾	161	19	1	55¾	227	2	10

COURTRAI—*Continued.*

Crowns.		£ s. d.	Crowns.		£ s. d.	Crowns.		£ s. d.
56	......	228 3 3	57½	......	234 5 4	59	......	240 7 6
56¼	......	229 3 8	57¾	......	235 5 8	59¼	......	241 7 10
56½	......	230 4 0	58	......	236 6 1	59½	......	242 8 3
56¾	......	231 4 4	58¼	......	237 6 5	59¾	......	243 8 8
57	......	232 4 8	58½	......	238 6 10	60	......	244 9 0
57¼	......	233 5 0	58¾	......	239 7 2			

BRUGES.

Price—Stuivers per Stone.

A Stuiver = 9 centimes ·07 decls.
A Stone = 8lb. 4oz. ·7407 do.
270 Stones = 1 Ton, nett.

Stuivers.		£ s. d.	Stuivers.		£ s. d.	Stuivers.		£ s. d.
35	......	34 5 8	60	......	58 15 3	85	......	83 5 0
35½	......	34 15 5	60½	......	59 5 1	85½	......	83 14 10
36	......	35 5 3	61	......	59 14 10	86	......	84 4 7
36½	......	35 15 1	61½	......	60 4 8	86½	......	84 14 5
37	......	36 4 10	62	......	60 14 5	87	......	85 4 2
37½	......	36 14 7	62½	......	61 4 3	87½	......	85 14 0
38	......	37 4 5	63	......	61 14 0	88	......	86 3 10
38½	......	37 14 3	63½	......	62 3 10	88½	......	86 13 7
39	......	38 4 0	64	......	62 13 7	89	......	87 3 5
39½	......	38 13 10	64½	......	63 3 5	89½	......	87 13 2
40	......	39 3 7	65	......	63 13 2	90	......	88 3 0
40½	......	39 13 5	65½	......	64 3 0	90½	......	88 12 9
41	......	40 3 2	66	......	64 12 9	91	......	89 2 7
41½	......	40 13 0	66½	......	65 2 7	91½	......	89 12 4
42	......	41 2 9	67	......	65 12 4	92	......	90 2 2
42½	......	41 12 7	67½	......	66 2 2	92½	......	90 11 11
43	......	42 2 4	68	......	66 12 0	93	......	91 1 9
43½	......	42 12 2	68½	......	67 2 0	93½	......	91 11 6
44	......	43 1 11	69	......	67 11 9	94	......	92 1 4
44½	......	43 11 9	69½	......	68 1 7	94½	......	92 11 1
45	......	44 1 6	70	......	68 11 4	95	......	93 0 11
45½	......	44 11 4	70½	......	69 1 2	95½	......	93 10 9
46	......	45 1 1	71	......	69 10 11	96	......	94 0 6
46½	......	45 10 11	71½	......	70 0 9	96½	......	94 10 4
47	......	46 0 8	72	......	70 10 6	97	......	95 0 1
47½	......	46 10 6	72½	......	71 0 2	97½	......	95 9 11
48	......	47 0 3	73	......	71 9 11	98	......	95 19 9
48½	......	47 10 1	73½	......	71 19 9	98½	......	96 9 8
49	......	47 19 10	74	......	72 9 6	99	......	96 19 5
49½	......	48 9 8	74½	......	72 19 4	99½	......	97 9 3
50	......	48 19 5	75	......	73 9 1	100	......	97 19 0
50½	......	49 9 3	75½	......	73 18 11	100½	......	98 8 10
51	......	49 19 0	76	......	74 8 9	101	......	98 18 7
51½	......	50 8 10	76½	......	74 18 6	101½	......	99 8 5
52	......	50 18 7	77	......	75 8 4	102	......	99 18 3
52½	......	51 8 5	77½	......	75 18 1	102½	......	100 8 0
53	......	51 18 2	78	......	76 7 11	103	......	100 17 10
53½	......	52 8 0	78½	......	76 17 8	103½	......	101 7 8
54	......	52 17 9	79	......	77 7 6	104	......	101 17 5
54½	......	53 7 7	79½	......	77 17 3	104½	......	102 7 3
55	......	53 17 4	80	......	78 7 1	105	......	102 17 4
55½	......	54 7 2	80½	......	78 16 11	105½	......	103 6 10
56	......	54 16 11	81	......	79 6 8	106	......	103 16 8
56½	......	55 6 9	81½	......	79 16 6	106½	......	104 6 5
57	......	55 16 6	82	......	80 6 3	107	......	104 16 3
57½	......	56 6 4	82½	......	80 16 1	107½	......	105 6 0
58	......	56 16 1	83	......	81 5 10	108	......	105 15 10
58½	......	57 5 11	83½	......	81 15 8	108½	......	106 5 7
59	......	57 15 8	84	......	82 5 5	109	......	106 15 5
59½	......	58 5 6	84½	......	82 15 3	109½	......	107 5 3

BRUGES—*Continued.*

Stuivers.		£ s. d.	Stuivers.		£ s. d.	Stuivers.		£ s. d.
110	......	107 15 0	113½	......	111 3 8	117	......	114 12 3
110½	......	108 4 10	114	......	111 13 5	117½	......	115 2 0
111	......	108 14 8	114½	......	112 3 3	118	......	115 11 10
111½	......	109 4 5	115	......	112 13 0	118½	......	116 1 7
112	......	109 14 3	115½	......	113 2 10	119	......	116 11 5
112½	......	110 4 0	116	......	113 12 8	119½	......	117 1 3
113	......	110 13 10	116½	......	114 2 5	120	......	117 10 11

WAEREGHEM OR BLUE COURTRAI.

Price—Stuivers per Stone.

A Stuiver = 9 centimes ·07 decls.
A Stone = 6lb. 10·9851oz.
335 Stones = 1 Ton, nett.

Stuivers.		£ s. d.	Stuivers.		£ s. d.	Stuivers.		£ s. d.
35	......	42 10 9	57	......	69 5 6	79	......	96 0 5
35½	......	43 2 11	57½	......	69 17 8	79½	......	96 12 7
36	......	43 15 0	58	......	70 9 10	80	......	97 4 8
36½	......	44 7 2	58½	......	71 2 0	80½	......	97 16 10
37	......	44 19 4	59	......	71 14 2	81	......	98 9 0
37½	......	45 11 6	59½	......	72 6 3	81½	......	99 1 1
38	......	46 3 8	60	......	72 18 5	82	......	99 13 4
38½	......	46 15 10	60½	......	73 10 7	82½	......	100 5 5
39	......	47 8 0	61	......	74 2 9	83	......	100 17 7
39½	......	48 0 1	61½	......	74 14 10	83½	......	101 9 9
40	......	48 12 3	62	......	75 7 0	84	......	102 1 10
40½	......	49 4 5	62½	......	75 19 1	84½	......	102 14 0
41	......	49 16 7	63	......	76 11 3	85	......	103 6 2
41½	......	50 8 9	63½	......	77 3 5	85½	......	103 18 5
42	......	51 0 11	64	......	77 15 7	86	......	104 10 6
42½	......	51 13 0	64½	......	78 7 8	86½	......	105 2 8
43	......	52 5 2	65	......	78 19 11	87	......	105 14 10
43½	......	52 17 4	65½	......	79 12 0	87½	......	106 6 11
44	......	53 9 5	66	......	80 4 2	88	......	106 19 1
44½	......	54 1 7	66½	......	80 16 4	88½	......	107 11 5
45	......	54 13 9	67	......	81 8 6	89	......	108 3 7
45½	......	55 5 11	67½	......	82 0 8	89½	......	108 15 8
46	......	55 18 1	68	......	82 12 10	90	......	109 7 10
46½	......	56 10 3	68½	......	83 5 0	90½	......	110 0 0
47	......	57 2 5	69	......	83 17 3	91	......	110 12 0
47½	......	57 14 6	69½	......	84 9 4	91½	......	111 4 2
48	......	58 6 8	70	......	85 1 6	92	......	111 16 4
48½	......	58 18 9	70½	......	85 13 8	92½	......	112 8 5
49	......	59 10 11	71	......	86 5 10	93	......	113 0 7
49½	......	60 3 1	71½	......	86 18 0	93½	......	113 12 9
50	......	60 15 3	72	......	87 10 2	94	......	114 4 10
50½	......	61 7 5	72½	......	88 2 4	94½	......	114 17 0
51	......	61 19 7	73	......	88 14 6	95	......	115 9 1
51½	......	62 11 9	73½	......	89 6 8	95½	......	116 1 2
52	......	63 4 0	74	......	89 18 10	96	......	116 13 4
52½	......	63 16 1	74½	......	90 11 0	96½	......	117 5 6
53	......	64 8 3	75	......	91 3 1	97	......	117 17
53½	......	65 0 5	75½	......	91 15 3	97½	......	118 9 10
54	......	65 12 6	76	......	92 7 5	98	......	119 2 0
54½	......	66 4 9	76½	......	92 19 7	98½	......	119 14 2
55	......	66 16 11	77	......	93 11 9	99	......	120 6 4
55½	......	67 9 1	77½	......	94 3 11	99½	......	120 18 6
56	......	68 1 3	78	......	94 16 1	100	......	121 10 9
56½	......	68 13 5	78½	......	95 8			

GHENT, WETTEREN, WELLE, Etc.

Price—Stuivers per Stone.

A Stuiver = 9 centimes ·07 decls.
A Stone = 6lb. 9·4117oz.
340 Stones = 1 Ton, nett.

Stuivers.	£	s.	d.	Stuivers.	£	s.	d.	Stuivers.	£	s.	d.
35	43	3	5	55½	68	9	1	76	93	14	10
35½	43	15	9	56	69	1	5	76½	94	7	2
36	44	8	1	56½	69	13	9	77	94	19	5
36½	45	0	5	57	70	6	1	77½	95	11	9
37	45	12	9	57½	70	18	5	78	96	4	2
37½	46	5	1	58	71	10	9	78½	96	16	6
38	46	17	5	58½	72	3	1	79	97	8	10
38½	47	9	9	59	72	15	5	79½	98	1	2
39	48	2	1	59½	73	7	9	80	98	13	6
39½	48	14	5	60	74	0	1	80½	99	5	10
40	49	6	9	60½	74	12	5	81	99	18	3
40½	49	19	1	61	75	4	9	81½	100	10	7
41	50	11	5	61½	75	17	1	82	101	2	11
41½	51	3	9	62	76	9	5	82½	101	15	3
42	51	16	1	62½	77	1	9	83	102	7	7
42½	52	8	5	63	77	14	1	83½	102	19	11
43	53	0	9	63½	78	6	5	84	103	12	3
43½	53	13	1	64	78	18	9	84½	104	4	8
44	54	5	5	64½	79	11	1	85	104	16	11
44½	54	17	9	65	80	3	5	85½	105	9	4
45	55	10	1	65½	80	15	9	86	106	1	8
45½	56	2	5	66	81	8	1	86½	106	14	0
46	56	14	9	66½	82	0	5	87	107	6	4
46½	57	7	1	67	82	12	9	87½	107	18	8
47	57	19	5	67½	83	5	1	88	108	11	0
47½	58	11	9	68	83	17	5	88½	109	3	4
48	59	4	1	68½	84	9	9	89	109	15	8
48½	59	16	5	69	85	2	1	89½	110	8	0
49	60	8	9	69½	85	14	5	90	111	0	4
49½	61	1	1	70	86	6	9	90½	111	12	8
50	61	13	5	70½	86	19	1	91	112	5	0
50½	62	5	9	71	87	11	5	91½	112	17	4
51	62	18	1	71½	88	3	8	92	113	9	8
51½	63	10	5	72	88	16	1	92½	114	2	0
52	64	2	9	72½	89	8	6	93	114	14	4
52½	64	15	1	73	90	0	10	93½	115	6	8
53	65	7	5	73½	90	13	2	94	115	19	0
53½	65	19	9	74	91	5	6	94½	116	11	4
54	66	12	1	74½	91	17	10	95	117	3	8
54½	67	4	5	75	92	10	2				
55	67	16	9	75½	93	2	6				

ST. NICHOLAS, MALINES, AND LOKEREN.

Price—Stuivers per Stone.

A Stuiver = 9 centimes ·07 decls.
A Stone = 6lb. 3·5555oz.
360 Stones = 1 Ton, nett.

Stuivers.	£	s.	d.	Stuivers.	£	s.	d.	Stuivers.	£	s.	d.
35	45	14	3	39½	51	11	9	44	57	9	4
35½	46	7	4	40	52	4	10	44½	58	2	4
36	47	0	5	40½	52	17	11	45	58	15	5
36½	47	13	5	41	53	10	11	45½	59	8	6
37	48	6	6	41½	54	4	0	46	60	1	6
37½	48	19	6	42	54	17	1	46½	60	14	7
38	49	12	7	42½	55	10	1	47	61	7	8
38½	50	5	8	43	56	3	2	47½	62	0	8
39	50	18	9	43½	56	16	3	48	62	13	9

ST. NICHOLAS, MALINES, AND LOKEREN—*Continued.*

Stuivers.	£	s.	d.	Stuivers.	£	s.	d.	Stuivers.	£	s.	d.
48½	63	6	10	69½	90	15	3	90½	118	4	0
49	63	19	11	70	91	8	4	91	118	17	1
49½	64	12	11	70½	92	1	5	91½	119	10	2
50	65	6	0	71	92	14	5	92	120	3	2
50½	65	19	1	71½	93	7	6	92½	120	16	3
51	66	12	1	72	94	0	7	93	121	9	4
51½	67	5	2	72½	94	13	7	93½	122	2	5
52	67	18	3	73	95	6	8	94	122	15	6
52½	68	11	3	73½	95	19	9	94½	123	8	7
53	69	4	4	74	96	12	10	95	124	1	8
53½	69	17	5	74½	97	5	10	95½	124	14	9
54	70	10	6	75	97	18	11	96	125	7	10
54½	71	3	6	75½	98	12	0	96½	126	0	10
55	71	16	7	76	99	5	0	97	126	13	11
55½	72	9	8	76½	99	18	1	97½	127	7	0
56	73	2	8	77	100	11	2	98	128	0	0
56½	73	15	9	77½	101	4	2	98½	128	13	1
57	74	8	10	78	101	17	3	99	129	6	2
57½	75	1	10	78½	102	10	4	99½	129	19	3
58	75	14	11	79	103	3	5	100	130	12	3
58½	76	8	0	79½	103	16	6	100½	131	5	4
59	77	1	1	80	104	9	8	101	131	18	5
59½	77	14	1	80½	105	2	10	101½	132	11	5
60	78	7	2	81	105	15	10	102	133	4	6
60½	79	0	3	81½	106	8	11	102½	133	17	7
61	79	13	3	82	107	2	0	103	134	10	7
61½	80	6	4	82½	107	15	1	103½	135	3	8
62	80	19	5	83	108	8	2	104	135	16	9
62½	81	12	5	83½	109	1	2	104½	136	9	10
63	82	5	6	84	109	14	3	105	137	2	10
63½	82	18	7	84½	110	7	4	105½	137	15	11
64	83	11	8	85	111	0	4	106	138	9	0
64½	84	4	8	85½	111	13	5	106½	139	2	1
65	84	17	9	86	112	6	6	107	139	15	1
65½	85	10	10	86½	112	19	6	107½	140	8	2
66	86	3	10	87	113	12	7	108	141	1	3
66½	86	16	11	87½	114	5	8	108½	141	14	4
67	87	10	0	88	114	18	9	109	142	7	4
67½	88	3	0	88½	115	11	10	109½	143	0	5
68	88	16	1	89	116	4	10	110	143	13	6
68½	89	9	2	89½	116	17	11				
69	90	2	2	90	117	11	0				

DUTCH.

Price—Stuivers per Stone.

A Dutch Stuiver	=	10 centimes ·58 decls.
A Stone	=	6lb. 3·5555oz.
360 Stones	=	1 Ton, nett.

Stuivers.	£	s.	d.	Stuivers.	£	s.	d.	Stuivers.	£	s.	d
25	38	1	9	32½	49	10	3	40	60	18	9
25½	38	17	0	33	50	5	6	40½	61	14	0
26	39	12	3	33½	51	0	8	41	62	9	2
26½	40	7	5	34	51	15	11	41½	63	4	5
27	41	2	8	34½	52	11	2	42	63	19	8
27½	41	18	0	35	53	6	5	42½	64	14	11
28	42	13	2	35½	54	1	8	43	65	10	2
28½	43	8	5	36	54	16	10	43½	66	5	4
29	44	3	7	36½	55	12	1	44	67	0	7
29½	44	18	10	37	56	7	4	44½	67	15	10
30	45	14	1	37½	57	2	7	45	68	11	1
30½	46	9	4	38	57	17	10	45½	69	6	3
31	47	4	6	38½	58	13	0	46	70	1	6
31½	47	19	9	39	59	8	3	46½	70	16	9
32	48	15	0	39½	60	3	6	47	71	11	11

DUTCH—*Continued.*

Stuivers.	£	s.	d.	Stuivers.	£	s.	d.	Stuivers.	£	s.	d.
47½	72	7	2	63½	96	14	10	79½	121	2	5
48	73	2	5	64	97	10	1	80	121	17	7
48½	73	17	8	64½	98	5	4	80½	122	12	10
49	74	12	11	65	99	0	7	81	123	8	1
49½	75	8	2	65½	99	15	9	81½	124	3	4
50	76	3	4	66	100	11	0	82	124	18	7
50½	76	18	7	66½	101	6	3	82½	125	13	10
51	77	13	10	67	102	1	6	83	126	9	0
51½	78	9	1	67½	102	16	9	83½	127	4	3
52	79	4	3	68	103	12	0	84	127	19	6
52½	79	19	6	68½	104	7	2	84½	128	14	9
53	80	14	9	69	105	2	5	85	129	10	0
53½	81	10	0	69½	105	17	8	85½	130	5	2
54	82	5	3	70	106	12	11	86	131	0	5
54½	83	0	5	70½	107	8	2	86½	131	15	8
55	83	15	8	71	108	3	4	87	132	10	11
55½	84	10	11	71½	108	18	7	87½	133	6	1
56	85	6	2	72	109	13	10	88	134	1	4
56½	86	1	5	72½	110	9	1	88½	134	16	7
57	86	16	7	73	111	4	4	89	135	11	10
57½	87	11	10	73½	111	19	7	89½	136	7	1
58	88	7	1	74	112	14	9	90	137	2	4
58½	89	2	4	74½	113	10	0	90½	137	17	6
59	89	17	7	75	114	5	3	91	138	12	9
59½	90	12	9	75½	115	0	6	91½	139	8	0
60	91	8	0	76	115	15	9	92	140	3	3
60½	92	3	3	76½	116	11	0	92½	140	18	5
61	92	18	6	77	117	6	2	93	141	13	8
61½	93	13	9	77½	118	1	5	93½	142	8	11
62	94	8	11	78	118	16	8	94	143	4	2
62½	95	4	3	78½	119	11	11	94½	143	19	5
63	95	19	7	79	120	7	2	95	144	14	8

WALLOON.

Price—Sous per Botte.

A Sous = 5 centimes.
A Botte = 3lb. 3·20oz.
700 Bottes = 1 Ton, nett.

Sous.	£	s.	d.	Sous.	£	s.	d.	Sous.	£	s.	d.
20	28	0	0	33	46	4	0	46	64	8	0
20½	28	14	0	33½	46	18	0	46½	65	2	0
21	29	8	0	34	47	12	0	47	65	16	0
21½	30	2	0	34½	48	6	0	47½	66	10	0
22	30	16	0	35	49	0	0	48	67	4	0
22½	31	10	0	35½	49	14	0	48½	67	18	0
23	32	4	0	36	50	8	0	49	68	12	0
23½	32	18	0	36½	51	2	0	49½	69	6	0
24	33	12	0	37	51	16	0	50	70	0	0
24½	34	6	0	37½	52	10	0	50½	70	14	0
25	35	0	0	38	53	4	0	51	71	8	0
25½	35	14	0	38½	53	18	0	51½	72	2	0
26	36	8	0	39	54	12	0	52	72	16	0
26½	37	2	0	39½	55	6	0	52½	73	10	0
27	37	16	0	40	56	0	0	53	74	4	0
27½	38	10	0	40½	56	14	0	53½	74	18	0
28	39	4	0	41	57	8	0	54	75	12	0
28½	39	18	0	41½	58	2	0	54½	76	6	0
29	40	12	0	42	58	16	0	55	77	0	0
29½	41	6	0	42½	59	10	0	55½	77	14	0
30	42	0	0	43	60	4	0	56	78	8	0
30½	42	14	0	43½	60	18	0	56½	79	2	0
31	43	8	0	44	61	12	0	57	79	16	0
31½	44	2	0	44½	62	6	0	57½	80	10	0
32	44	16	0	45	63	0	0	58	81	4	0
32½	45	10	0	45½	63	14	0	58½	81	18	0

WALLOON—*Continued.*

Sous.	£ s. d.	Sous.	£ s. d.	Sous.	£ s. d.
59	82 12 0	68	95 4 0	77	107 16 0
59½	83 6 0	68½	95 18 0	77½	108 10 0
60	84 0 0	69	96 12 0	78	109 4 0
60½	84 14 0	69½	97 6 0	78½	109 18 0
61	85 8 0	70	98 0 0	79	110 12 0
61½	86 2 0	70½	98 14 0	79½	111 6 0
62	86 16 0	71	99 8 0	80	112 0 0
62½	87 10 0	71½	100 2 0	80½	112 14 0
63	88 4 0	72	100 16 0	81	113 8 0
63½	88 18 0	72½	101 10 0	81½	114 2 0
64	89 12 0	73	102 4 0	82	114 16 0
64½	90 6 0	73½	102 18 0	82½	115 10 0
65	91 0 0	74	103 12 0	83	116 4 0
65½	91 14 0	74½	104 6 0	83½	116 18 0
66	92 8 0	75	105 0 0	84	117 12 0
66½	93 2 0	75½	105 14 0	84½	118 6 0
67	93 16 0	76	106 8 0	85	119 0 0
67½	94 10 0	76½	107 2 0		

FURNES.

Price—Sous per Botte.

A Sous = 5 centimes.
A Botte = 3lb. 2·4788oz.
710 Bottes = 1 Ton, nett.

Sous.	£ s. d.	Sous.	£ s. d.	Sous.	£ s. d.
25	35 10 0	43½	61 15 5	62	88 0 10
25½	36 4 2	44	62 9 7	62½	88 15 0
26	36 18 5	44½	63 3 10	63	89 9 2
26½	37 12 7	45	63 18 0	63½	90 3 5
27	38 6 10	45½	64 12 2	64	90 17 7
27½	39 1 0	46	65 6 5	64½	91 11 10
28	39 15 2	46½	66 0 7	65	92 6 0
28½	40 9 5	47	66 14 10	65½	93 0 2
29	41 3 7	47½	67 9 0	66	93 14 5
29½	41 17 10	48	68 3 2	66½	94 8 7
30	42 12 0	48½	68 17 5	67	95 2 10
30½	43 6 2	49	69 11 7	67½	95 17 0
31	44 0 5	49½	70 5 10	68	96 11 2
31½	44 14 7	50	71 0 0	68½	97 5 5
32	45 8 10	50½	71 14 2	69	97 19 7
32½	46 3 0	51	72 8 5	69½	98 13 10
33	46 17 3	51½	73 2 7	70	99 8 0
33½	47 11 5	52	73 16 10	70½	100 2 2
34	48 5 7	52½	74 11 0	71	100 16 5
34½	48 19 10	53	75 5 3	71½	101 10 7
35	49 14 0	53½	75 19 5	72	102 4 10
35½	50 8 2	54	76 13 7	72½	102 19 0
36	51 2 5	54½	77 7 10	73	103 13 2
36½	51 16 7	55	78 2 0	73½	104 7 5
37	52 10 10	55½	78 16 2	74	105 1 7
37½	53 5 0	56	79 10 5	74½	105 15 10
38	53 19 2	56½	80 4 7	75	106 10 0
38½	54 13 5	57	80 18 10	75½	107 4 2
39	55 7 7	57½	81 13 0	76	107 18 5
39½	56 1 10	58	82 7 2	76½	108 12 7
40	56 16 0	58½	83 1 5	77	109 6 10
40½	57 10 2	59	83 15 7	77½	110 1 0
41	58 4 5	59½	84 9 10	78	110 15 2
41½	58 18 7	60	85 4 0	78½	111 9 5
42	59 12 10	60½	85 18 2	79	112 3 7
42½	60 7 0	61	86 12 5	79½	112 17 10
	61 1 2	61½	87 6 7	80	113 12 0

BERGUES.

Price—Sous per Botte.

A Sous = 5 centimes.
A Botte = 3lb. 4·7058oz.
680 Bottes = 1 Ton, nett.

Sous.	£	s.	d.	Sous.	£	s.	d.	Sous.	£	s.	d.
25	34	0	0	43½	59	3	2	62	84	6	5
25½	34	13	7	44	59	16	10	62½	85	0	0
26	35	7	2	44½	60	10	5	63	85	13	7
26½	36	0	10	45	61	4	0	63½	86	7	2
27	36	14	5	45½	61	17	7	64	87	0	10
27½	37	8	0	46	62	11	2	64½	87	14	5
28	38	1	7	46½	63	4	10	65	88	8	0
28½	38	15	2	47	63	18	5	65½	89	1	7
29	39	8	10	47½	64	12	0	66	89	15	2
29½	40	2	5	48	65	5	7	66½	90	8	10
30	40	16	0	48½	65	19	2	67	91	2	5
30½	41	9	7	49	66	12	10	67½	91	16	0
31	42	3	2	49½	67	6	5	68	92	9	7
31½	42	16	10	50	68	0	0	68½	93	3	2
32	43	10	5	50½	68	13	7	69	93	16	10
32½	44	4	0	51	69	7	2	69½	94	10	5
33	44	17	7	51½	70	0	10	70	95	4	0
33½	45	11	2	52	70	14	5	70½	95	17	7
34	46	4	10	52½	71	8	0	71	96	11	2
34½	46	18	5	53	72	1	7	71½	97	4	10
35	47	12	0	53½	72	15	2	72	97	18	5
35½	48	5	7	54	73	8	10	72½	98	12	0
36	48	19	2	54½	74	2	5	73	99	5	7
36½	49	12	10	55	74	16	0	73½	99	19	2
37	50	6	5	55½	75	9	7	74	100	12	10
37½	51	0	0	56	76	3	2	74½	101	6	5
38	51	13	7	56½	76	16	10	75	102	0	0
38½	52	7	2	57	77	10	5	75½	102	13	7
39	53	0	10	57½	78	4	0	76	103	7	2
39½	53	14	5	58	78	17	7	76½	104	0	10
40	54	8	0	58½	79	11	2	77	104	14	5
40½	55	1	7	59	80	4	10	77½	105	8	0
41	55	15	2	59½	80	18	5	78	106	1	7
41½	56	8	10	60	81	12	0	78½	106	15	2
42	57	2	5	60½	82	5	7	79	107	8	10
42½	57	16	0	61	82	19	2	79½	108	2	5
43	58	9	7	61½	83	12	10	80	108	16	0

MOY.

Price—Sous per Botte.

A Sous = 5 centimes.
A Botte = 3lb. 1·0959oz.
730 Bottes = 1 Ton, nett.

Sous.	£	s.	d.	Sous.	£	s.	d.	Sous.	£	s.	d.
25	36	10	0	32½	47	9	0	40	58	8	0
25½	37	4	7	33	48	3	7	40½	59	2	7
26	37	19	2	33½	48	18	3	41	59	17	3
26½	38	13	10	34	49	12	10	41½	60	11	10
27	39	8	5	34½	50	7	5	42	61	6	5
27½	40	3	0	35	51	2	0	42½	62	1	0
28	40	17	8	35½	51	16	7	43	62	15	7
28½	41	12	3	36	52	11	3	43½	63	10	3
29	42	6	10	36½	53	5	10	44	64	4	10
29½	43	1	5	37	54	0	5	44½	64	19	5
30	43	16	0	37½	54	15	0	45	65	14	0
30½	44	10	7	38	55	9	7	45½	66	8	8
31	45	5	3	38½	56	4	3	46	67	3	3
31½	45	19	10	39	56	18	10	46½	67	17	10
32	46	14	5	39½	57	13	5	47	68	12	5

MOY—*Continued.*

Sous.	£ s. d.	Sous.	£ s. d.	Sous.	£ s. d.
47½	69 7 0	60½	88 6 8	73½	107 6 3
48	70 1 8	61	89 1 3	74	108 0 10
48½	70 16 3	61½	89 15 10	74½	108 15 5
49	71 10 10	62	90 10 5	75	109 10 0
49½	72 5 5	62½	91 5 0	75½	110 4 8
50	73 0 0	63	91 19 8	76	110 19 3
50½	73 14 8	63½	92 14 3	76½	111 13 10
51	74 9 3	64	93 8 10	77	112 8 5
51½	75 3 10	64½	94 3 5	77½	113 3 0
52	75 18 5	65	94 18 0	78	113 17 8
52½	76 13 0	65½	95 12 8	78½	114 12 3
53	77 7 8	66	96 7 3	79	115 6 10
53½	78 2 3	66½	97 1 10	79½	116 1 5
54	78 16 10	67	97 16 5	80	116 16 0
54½	79 11 5	67½	98 11 0	80½	117 10 8
55	80 6 0	68	99 5 8	81	118 5 3
55½	81 0 8	68½	100 0 3	81½	118 19 10
56	81 15 3	69	100 14 10	82	119 14 5
56½	82 9 10	69½	101 9 5	82½	120 9 0
57	83 4 5	70	102 4 0	83	121 3 8
57½	83 19 0	70½	102 18 8	83½	121 18 3
58	84 13 8	71	103 13 3	84	122 12 10
58½	85 8 3	71½	104 7 10	84½	123 7 5
59	86 12 10	72	105 2 5	85	124 2 0
59½	86 17 5	72½	105 17 0		
60	87 12 0	73	106 11 8		

BERNAY.

Price—Francs per 110 Livres.

A Franc = 9·6 pence.
A Livre = 1lb. 1·5685oz.
2040 Livres = 1 Ton, nett.

Francs.	£ s. d.	Francs.	£ s. d.	Francs.	£ s. d
45	33 7 8	81	60 1 8	117	86 15 10
46	34 2 6	82	60 16 6	118	87 10 8
47	34 17 4	83	61 11 4	119	88 5 6
48	35 12 2	84	62 6 2	120	89 0 4
49	36 7 0	85	63 1 0	121	89 15 2
50	37 1 10	86	63 15 10	122	90 10 0
51	37 16 8	87	64 10 8	123	91 4 10
52	38 11 6	88	65 5 6	124	91 19 8
53	39 6 4	89	66 0 4	125	92 14 6
54	40 1 2	90	66 15 4	126	93 9 4
55	40 16 0	91	67 10 2	127	94 4 2
56	41 10 10	92	68 5 0	128	94 19 0
57	42 5 8	93	68 19 10	129	95 13 10
58	43 0 6	94	69 14 8	130	96 8 8
59	43 15 4	95	70 9 6	131	97 3 6
60	44 10 2	96	71 4 4	132	97 18 4
61	45 5 0	97	71 19 2	133	98 13 2
62	45 19 10	98	72 14 0	134	99 8 0
63	46 14 8	99	73 8 10	135	100 2 10
64	47 9 6	100	74 3 8	136	100 17 8
65	48 4 4	101	74 18 6	137	101 12 6
66	48 19 2	102	75 13 4	138	102 7 4
67	49 14 0	103	76 8 2	139	103 2 2
68	50 8 10	104	77 3 0	140	103 17 0
69	51 3 8	105	77 17 10	141	104 11 10
70	51 18 6	106	78 12 8	142	105 6 8
71	52 13 4	107	79 7 6	143	106 1 6
72	53 8 2	108	80 2 4	144	106 16 4
73	54 3 0	109	80 17 2	145	107 11 2
74	54 17 10	110	81 12 0	146	108 6 0
75	55 12 8	111	82 6 10	147	109 0 10
76	56 7 6	112	83 1 8	148	109 15 8
77	57 2 4	113	83 16 6	149	110 10 7
78	57 17 2	114	84 11 4	150	111 5 6
79	58 12 0	115	85 6 2		
80	59 6 10	116	86 1 0		

NOTE VI.

ARCHANGEL AND ST. PETERSBURG DISTRICTS.

In the Melinky district the crop will be much more abundant than last year. In the Svoydol, Jurieff. and Vladimir, an average one. In the Vologda, Jaroslaf, Rostoff, and Ouglitch, a fair yield is expected. In the Viasma, Rjeff, and Tjoobtyoff it will be above the average. In the Soursk, Porchey, and Gorodity, very little flax. In Kostroma in some places the crop is good, in others an average one. In Viatka prospects are bad, and the yield will be small. Of Siberian tows a good yield may be expected; they are well spoken of. Of Kama tows, on the other hand, there will be less. On the whole, there is no doubt but that the crop is worse than last year's, as the growth has been very irregular, owing to climatic changes. The fibre also will be irregular in strength from the same cause. The present bad weather will not improve matters, as a great part of the flax has not yet been pulled.

St. Petersburg, 10/22*nd August*, 1877.—The more recent accounts of the fresh growth of flax are less satisfactory than they were. The Melinki and Moorum crop is a bad one. We hear from Perm and Viatka that the great heat has damaged the flax.

Pscow, 17/29*th August*, 1877.—In Livonia the reports are on the whole very favourable regarding the flax crop. The state of the fields, which the writer saw on his journey from Dorpat to Fellin, was very good. From our own district we have already received a few bundles of fresh flax; we find it of very good quality, and the fibre is strong, suitable for fine spinning.

Reval, 18/30*th August*, 1877.—Our flax crop is approaching maturity; pulling has already begun, and the result of the new crop is likely to surpass the highest expectations.

Pernan, 22*nd August*/3*rd September*, 1877.—The acreage under flax is, this year, about the same. Spring having set in very late this year, and the weather having been very cold, the sowing only began in the beginning of May, and was continued till the end of the month. The early sowing was at first hindered in its growth by cold and dry weather, but fortunately warm weather and rain set in at the proper time to prevent mischief; and the weather since having been in general favourable for the crop, the young plant developed itself well, and in general attained a satisfactory average length. In the beginning of August part of the flax, especially of the early sowing, was laid in the fields by heavy rains, which caused farmers and countrymen to begin pulling without delay, in some cases sacrificing the seed, which was not yet ripe. Since then pulling has constantly been continued, so that now only a proportion of the late sowing remains in the fields, for which apprehensions are entertained in consequence of slight night frosts, which we have had for some days past. Owing to the continued rain we have had lately, water is plentiful everywhere for steeping purposes, and if no injury is done to the crop by other causes later on, we may expect that the quality will turn out satisfactorily. The fibre will be clean and strong and of good spinning quality. As regards the quantity, it is difficult to give a reliable estimate, as it is not known yet how the straw will yield. Taking, however, into account that the acreage might have been less than last year, it will most likely not exceed last year's.

Riga, 24*th August*/5*th September*, 1877.—On the whole our advices lead us to expect a good average crop, although as regards length the flax will be found uneven. The excessive rains lately experienced are not believed to have done material harm to the flax crops, excepting in Livonia, where in some districts the flax had been laid, and peasants had been obliged to pull the flax prematurely. The best reports sent to us are from Lithuania and Ostroff, but as the pulling had by last accounts only just commenced in the earliest districts (excepting, of course, where it had been prematurely carried out), our reports can only be based on opinion. The weather of the next few weeks must still have a material influence on the final result.

MEMEL, *7th September*, 1877.—There seems no doubt but that in our districts we will have a fair quantity of flax, and the quality also, it seems, will be good. We believe, however, the flax this season will be very late.

KONIGSBERG, *31st August*, 1877.—The prospects of the flax crop are so far turning out all right. It seems in many of the Russian districts the flax is now pulled, and the quality appears to come up to the expectations formed.

BRUNSWICK, *8th September*, 1877.—The young plant this year suffered much from drought during the months of May and June, when damp and wet weather is much wanted for its development. The rain came too late in many cases, and could therefore only exercise partly a beneficial effect on the flax crops. After all that has transpired as to the crop, the prospects are this year highly unsatisfactory; in many districts where the plant grew up in a sandy bottom the flax remained very short, and is even considered not to be worth dressing, which will give a considerable loss in the yield of the crop. The flax in the lower situated and heavier ground could better resist the influence of the drought, and these districts have produced a growth of good quality and sufficient length in its fibre. Though a larger breadth has been sown with linseed this spring in comparison to preceding years, the quantity of the flax crop is estimated to be scarcely an average one.

BRAUNSBERG, *29th August*, 1877.—According to your wish, we beg now to wait upon you with such information as to our new flax crop as we could obtain by our own inspection, and by such advices as we received through our friends in the more distant parts of the country.

In general, fully one-third less flax has been sown in this part of the country compared to former years. Farmers thought it more profitable to extend their cultivation to grain and other produce, because this year's prices of flax did not at all correspond with their view, and with the rent they used to derive from their lands. Sowing generally did not commence before the 8th of June, when the seed got into an uncommonly dry soil, and, owing to the continual drought, it was a long time before the plant made its appearance, and then even could make only slow progress in growing. Since July, however, we had plenty of rain, which not only improved the appearance of the crop considerably, but, indeed, made it reach such a height as we have not seen for some years past. We regret, however, to state that the continual showers which, with very little interruption, have prevailed ever since, have done great injury to the crop, as many fields have been seriously laid; and, to prevent rotting, some of our farmers have already commenced pulling their flax, although still green. Thus they will at least lose the seed. Our this year's flax crop will therefore be deficient in quantity, but superior in quality, especially as there is plenty of water for steeping, which in former years frequently has been wanting, and been the cause of inferior quality.

LILLE, *29th August*, 1877.—I give you all the crop advices I could procure. *Lille*—Ordinary sowing, and pretty good yield. *Bergues*—Ordinary sowing; satisfactory yield. *Douai*—Unimportant sowing; satisfactory yield. *Picardy*—Less important sowing than usual; pretty good yield. *Taissonais*—Much less sowing than ordinary year; good yield. *Caux*—Ordinary sowing; good yield. *Mayenne*—Ordinary sowing; bad yield. *Bretagne*—Unimportant sowing; bad yield. *General estimate*—The crop is rather less than half an average.

GHENT, *24th August*, 1877.—Our new flax being pulled and almost all steeped, I take the liberty of waiting upon you with my annual report on the condition of our crop. *Quantity.*—Owing to the wet weather in the month of March, much less flax was sown in the heavy lands in the north of Belgium, but the flax sown in the light lands is above a medium length, and will give a better yield than last year, so that I consider the crop will be an average one. *Length* will be of a good average. *Quality* is considered as good, and some of the flax will be finer than that of last year. The fibre is generally very fine and round. *Colour* will be good; the new flax I have seen up to date is very regular in this respect.

COURTRAI.—The weather has been very favourable for the steeping of the 1877 flax, and up to now there is every sign that there will be much good flax.

WALLOON.—The crop will be a good average one in respect to quantity, but it is a fortnight too early to be able to form an exact opinion as to quality.

September 4*th*, 1877.—The Flemish crop has been housed in excellent condition, and promises very well. The Dutch flax, on the other hand, has suffered somewhat from rain, and is generally inferior to the Flemish, though some portion is good, and especially the large remnant of the crop of 1876.

ANTWERP, 25*th August*, 1877.—For a fortnight we have had very rainy weather, and so far the barometer does not betoken a change. This rainy weather obliges the farmers to take up sooner than customary the fresh flax spread on the fields, which will make the fibre in many cases strawy. Several samples of fresh flax have already been shown on the markets in the interior, and generally the quality is preferred to that of last year's flax; but, on the other hand, the opinion gains ground more and more that as to quantity our new crop will show a deficiency of about one-fourth. The yield of what has been cleaned so far seems, however, to be rather better than was expected.

DOCKUM, 31*st August*, 1877.—Concerning the new flax crop, we have to inform you that the sowing of flax was this year larger than last year. The result, however, will be very disappointing to the farmers. The flax is still standing in the fields, but the constant rains have in several places rotted it, and this will cause the farmers besides to lose the flax seed. As a rule, the flax will this year be rather short, although some parcels will no doubt be of the usual length. The quality may be expected stronger than would have been the case if the summer had been dry. The sample tons which have been brought to the market are of pretty fair quality. If the weather would now keep dry, the quality would improve greatly, but on the whole we have only to expect an average flax crop, both as to quantity and quality.

ROTTERDAM, 28*th August*, 1877.—Referring to the new flax crop, the retting and grassing has proceeded under very favourable circumstances as to weather, etc. The few trial samples which we have seen have turned out only very middling; the yield from the straw, however, will be good. On the other hand, the colour is not so good as could be wished. This week very wet weather has set in, and should it continue, there is no doubt it will injuriously affect the remainder of our crop, which has still to be exposed to it after being taken out of the water.

ROTTERDAM, 29*th August*, 1877.—In Friesland and Groningen, the late rains have done considerable injury, but, on the whole, a fair average crop, as to quantity and quality, is expected.

COLERAINE, IRELAND, 29*th August*, 1877.—Owing to the unusual lateness of the sowing season in this country this year, flax pulling is only now general, and no samples of the new crop have yet appeared in our markets. The flax is bulking largely in the field, and is of good length, but I have grave apprehensions that the yield of fibre in the scutch mills will not be satisfactory, because of the very unfavourable weather for ripening the plant.

COOKSTOWN, 29*th August*, 1877.—Referring to the growth and probable turn out of the flax crop in Ireland, I regret to have to inform you that, in consequence of the prevalency of unseasonable and wet weather, during the months of July and August, neither the yield nor the quality of fibre will come up to the large expectations formed of it in the month of June. The extent to which the crop is cultivated this season exceeds 123,000 acres, which is a slight falling off compared with last season, when the acreage exceeded 132,000. The Spring was cold, and the sowing a fortnight later than usual. The brairds came up thick and evenly; the growth continued strong and promising, until it began to flower in the beginning of July, when heavy and continuous rains set in, and laid the crop, keeping it soft and growing, when the usual fine weather of that month was so much wanted to mature and firm the crop, which had already attained above an average growth. The weather continued wet up till the 10th August, when a week of fine weather set in, and a large part of the crop was pulled and steeped. The weather broke again on the 18th August, and rain fell heavily for three days, causing the rivers and streams to overflow their banks. The overflow of fresh water in the flax pools checked fermentation prematurely, and the flax then in the pools will be but partially retted, and will not clean out. Everywhere the crop has turned out heavy on the ground, and there is no doubt the yield will be large compared with preceding seasons; but both the yield and the quality of fibre will be deteriorated more or less by the prevailing wet weather of the past six weeks.

COURTRAI.—The young plant suffered seriously in our immediate neighbourhood from the drought and heat of early summer, causing it in many cases to pull thin and short, but as straw of superior quality from other districts has been pretty freely bought by the "fabricants," there will be an average quantity of all descriptions got forward, besides a full supply of last year's growth. The Lys has during the Summer and Autumn been in pretty good condition for steeping; the weather for grassing has also been favourable, so that we look for even, good colours, and very little of the "blash" which last season was found so injurious to our Courtrai. Supplies are not coming forward freely, as the continued fine weather keeps all hands out of doors, but rates of what is reach-market are moderate; a fair useful flax ranging from 19 to 20 crowns, with better sorts in proportion. Fine kinds very scarce as yet.

We look for a pretty large proportion of blue steeped Courtrai this season, many farmers preferring not to incur the expense of the Lys process with poor straw, of which there is, unfortunately, a good deal.

BRUGES district will afford a good supply of excellent quality, that part of the country having suffered least from the trying weather; there will be at the same time a portion of common and very inferior sorts, but on the whole the prospect from this important market is encouraging. Rates open moderate but supply is still very thin, field-work preventing scutching.

In Malines and St. Nicholas sowing was much smaller than last year, while in the latter district especially, the plant was stunted in its growth, and has pulled short and light to the acre. We thus expect the yield from these two markets to be about one-third less than last season.

In Lokeren, Ghent and Wetteren the acreage sown pretty nearly equalled last year, and, the plant having come up fairly, the quantity of straw will nearly equal last season.

Yield from the straw, of scutched fibre, is generally reported good; which will, to a certain extent, compensate for smaller acreage and thin growth, which was unfortunately not of rare occurrence.

Colours promise to be even, and the fibre very tough, unless where the plant received permanent injury from the drought. Roots will, we fear, generally be found heavy, but the tops in most cases will be pretty good.

Supplies of fresh flax, and, at Ghent, a little old also, are now coming forward, but, except at the above market, as yet thinly. Rates open at about £71 to £74 for very common, up to £90 for very superior, and we are glad to mention that quality, above the very inferior goods, is satisfactory, both in Warp and Weft descriptions.

In Holland we regret to advise a small, short, and very light crop; however, the quality of the samples is, on the whole, better than we had hoped, and with the good surplus of last year's straw, the deficiency will be in some measure made up. Only three small parcels were shown at last market, and it is thus too soon to quote prices.

NOTE VII.

	Experimenter "Muschenbrock."		Experimenter "Ebbels."						
	Cohesive power of a square inch.	Specific gravity.	Specific gravity.	Proportionate value of constant transverse strength.	Length in feet.	Breadth in inches.	Depth in inches.	Deflection.	Weight which produced deflection in lb.
WOODS.									
Walnut	8.130	..	925	1461	2·5	1·0	1·0	·5	62
Chestnut Tree	..	..	875	1350	2·5	1·0	1·0	·5	68
Acacia	20·582	..	820	1866	2·5	1·0	1·0	·5	125
Weych Elm	..	..	763	1440	2·5	1·0	1·0	·5	92
English Oak (green)	..	..	763	1741	2·5	1·0	1·0	·5	96
English Oak (dry)	17·300	..	748	2130	..	..	..	..	..
Birch	..	..	720	1551	2·5	1·0	1·0	·5	90
Ash	..	..	690	1905	2·5	1·0	1·0	·5	78
Beech	17·709	..	690	2031	2·5	1·0	1·0	·5	97
Plane Tree	..	..	648	1821	2·5	1·0	1·0	·5	99
Sycamore	..	..	590	1605	2·5	1·0	1·0	·5	76
British Spruce	..	..	555	..	2·5	1·0	1·0	·5	93
Fir (Spruce)	..	..	555	1395	..	..	..	..	..
Alder	14·186	..	555	1590	2·5	1·0	1·0	·5	80
Larch	..	..	554	..	2·5	1·0	1·0	·5	112
Elm	13·489	..	544	1620	2·5	1·0	1·0	·5	99
Fir (Riga)	..	..	464	..	2·5	1·0	1·0	·5	116
Fir (Scotch)	8·506	..	460	1176	..	..	..	..	..
Poplar (Lombardy)	6·641	..	375	981	2·5	1·0	1·0	·5	56
Pear Tree	..	..	..	..	2·5	1·0	1·0	·5	68
Cherry Tree	..	..	..	..	2·5	1·0	1·0	·5	92
Ash (dry)	12·000	..	..	..	..	..	..	..	..
Scotch Pine	7·816	..	..	..	..	..	..	..	..
Cedar	4·973	..	..	..	..	..	..	..	..
METALS.									
German bar Malleable, B.R.	61·361	..	..	..	..	..	..	..	..
Swedish do. do.	68·728	..	..	..	..	..	..	..	..
German do. do. L.	69·530	..	..	..	..	..	..	..	..
Leige do. do.	62·329	..	..	..	..	..	..	..	..
Spanish do. do.	81·901	..	..	..	..	..	..	..	..
Oosement do. do.	68·728	..	..	..	..	..	..	..	..
Common German bar Malleable	69·133	..	..	..	..	..	..	..	..
Cast Iron bar	68·295	7·807	..	..	..	..	..	..	..
Cast Copper (Barbary)	22·570	8·182	..	..	..	..	..	..	..
Do. (Japan)	20·272	8·726	..	..	..	..	..	..	..
Cast Silver	40·902	11·091	..	..	..	..	..	..	..
Cast Gold	20·450	19·238	..	..	..	..	..	..	..
Cast Zinc	2·689	..	..	..	..	..	..	..	..
Cast English Block Tin	6·650	..	..	..	..	..	..	..	..
Cast English Tin	5·322	7·295	..	..	..	..	..	..	..
Cast Banca Tin	3·679	7·216	..	..	..	..	..	..	..
Cast Malacca Tin	3·211	6·125	..	..	..	..	..	..	..
Lead Wire	3·146	..	..	..	..	..	..	..	..
Lead Wire	2·581	11·282	..	..	..	..	..	..	..
Cast English Lead	·885	11·479	..	..	..	..	..	..	..
Cast Bismuth	3·250	9·810	..	..	..	..	..	..	..

	Experimenter "Muschenbrock."		Experimenter "Ebbels."						
	Cohesive power of a square inch.	Specific gravity.	Specific gravity.	Proportionate value of constant transverse strength.	Length in feet.	Breadth in inches.	Depth in inches.	Deflection.	Weight which produced deflection in lb.
Bismuth	3·008	9·926	..	..	..	..	..	..	..
Cast Antimony	1·006	4·500	..	..	..	..	..	..	..
Copper.... 10 Tin 1	32·093	8·351	..	..	..	..	..	..	..
,, ... 8 ,, ... 1	36·088	8·392	..	..	..	..	..	..	..
,, ... 6 ,, ... 1	44·071	8·707	..	..	..	..	..	..	..
,, ... 4 ,, ... 1	35·739	8·723	..	..	..	..	..	..	..
,, ... 2 ,, ... 1	1·017	,,	..	..	..	..	..	..	..
English Tin 10 Lead 1	6·904	,,	..	..	..	..	..	..	..
,, ,, 8 ,, ... 1	7·922	,,	..	..	..	..	..	..	..
,, ,, 6 ,, ... 1	7·997	,,	..	..	..	..	..	..	..
,, ,, 4 ,, ... 1	10·607	,,	..	..	..	..	..	..	..
,, ,, 2 ,, ... 1	7·470	,,	..	..	..	..	..	..	..
,, ,, 1 ,, ... 1	7·074	,,	..	..	..	..	..	..	..
Banca Tin 10 Antimony .. 1	11·181	7·359	..	..	..	..	..	..	..
,, ,, 8 ,, ... 1	9·881	7·276	..	..	..	..	..	..	..
,, ,, 6 ,, ... 1	12·632	7·228	..	..	..	..	..	..	..
,, ,, 4 ,, ... 1	13·480	7·192	..	..	..	..	..	..	..
,, ,, 2 ,, ... 1	12·029	7·105	..	..	..	..	..	..	..
,, ,, 1 ,, ... 1	3·184	7·060	..	..	..	..	..	..	..
,, ,, 10 Bismuth .. 1	12·688	7·576	..	..	..	..	..	..	..
,, ,, 4 ,, ... 1	16·692	7·613	..	..	..	..	..	..	..
,, ,, 2 ,, ... 1	14·017	8·076	..	..	..	..	..	..	..
,, ,, 1 ,, ... 1	12·020	8·146	..	..	..	..	..	..	..
,, ,, 1 ,, ... 2	10·013	8·580	..	..	..	..	..	..	..
,, ,, 1 ,, ... 4	7·875	9·009	..	..	..	..	..	..	..
,, ,, 10 Zinc (India) 1	12·914	7·288	..	..	..	..	..	..	..
,, ,, 2 ,, ... 1	15·025	7·000	..	..	..	..	..	..	..
,, ,, 1 ,, ... 1	15·844	7·321	..	..	..	..	..	..	..
,, ,, 1 ,, ... 2	16·023	7·100	..	..	..	..	..	..	..
,, ,, 1 ,, ...10	5·671	7·130	..	..	..	..	..	..	..
English Tin 8 Zinc (Gosler) 1	10·607	,,	..	..	..	..	..	..	..
,, ,, 4 ,, ... 1	10·258	,,	..	..	..	..	..	..	..
,, ,, 2 ,, ... 1	10·964	,,	..	..	..	..	..	..	..
,, ,, 1 ,, ... 1	9·024	,,	..	..	..	..	..	..	..
,, ,, 1 Antimony .. 1	1·450	7·000	..	..	..	..	..	..	..
,, ,, 3 ,, ... 2	3·184	,,	..	..	..	..	..	..	..
,, ,, 4 ,, ... 1	11·343	,,	..	..	..	..	..	..	..
Scotch Lead 1 Bismuth 1	7·319	10·931	..	..	..	..	..	..	..
,, ,, 2 ,, ... 1	5·840	11·090	..	..	..	..	..	..	..
,, ,, 10 ,, ... 1	2·826	10·827	..	..	..	..	..	..	..

NOTE VIII.

The "specific gravity" and "cohesive force" of numerous kinds of wood, on the authority of Grier :—

Name of Wood.	Specific gravity.	Cohesive force of sq. inch in pounds weight.	Name of Wood.	Specific gravity.	Cohesive force of sq. inch in pounds weight.
Acacia	0·860	16·000	Lignum vitæ	1·220	11·800
Alder	0·800	14·186	Lime tree	0·760	23·500
Apple tree	0·793	14·186	Locust tree	0·760	20·582
Arbutus	0·793	7·667	Logwood	0·913	20·582
Arbutus	0·793	17·379	Mahogany	0·870	21·800
Ash	0·840	16·700	Mahogany (Spanish)	0·753	12·186
Ash	0·780	19·600	Maple (Norway)	0·793	10·584
Ash	0·780	17·000	Mastic tree	0·849	10·584
Ash	0·780	12·000	Medlar	0·941	10·584
Ash, red, seasoned	0·812	17·892	Mulberry	0·660	17·400
Ash, white, seasoned	0·685	14·220	Mulberry	0·660	10·600
Bay	0·822	14·572	Oak (American) white	0·660	11·501
Bay	0·822	10·220	Oak (Baltic) seasoned	0·673	11·412
Beech	0·720	22·200	Oak (Dantzic)	0·673	7·704
Beech	0·720	17·709	Oak (English)	0·673	8·820
Birch	0·640	15·000	Oak (English) old	0·760	14·000
Box	0·990	15·500	Oak, black lime-log	0·670	7·700
Box (French)	1·328	15·500	Oak (French) seasoned	0·670	9·043
Box (Brazilian)	1·031	15·500	Oak (French)	1·068	9·985
Cane	0·400	6·300	Oak (Hamburg)	0·600	16·300
Cedar	0·540	11·400	Oak (Hamburg)	0·660	14·000
Cedar	0·540	4·973	Oak (Provence)	0·771	12·839
Cedar (Indian)	1·315	4·973	Oak (Provence) seasoned	1·164	14·685
Cedar (Palestine)	0·613	4·973	Olive	0·927	14·685
Chestnut (horse)	0·610	12·100	Orange	0·705	14·685
Chestnut (sweet)	0·610	10·500	Pine, pitch	0·705	7·818
Chestnut (sweet) 100 years	0·877	12·158	Pine, pitch	0·705	13·176
Cherry tree	0·715	12·158	Pine (Norway)	0·590	12·400
Citron	0·715	8·176	Pine (Norway)	0·660	14·300
Citron	0·715	12·782	Pine (St. Petersburg)	0·550	13·100
Cocoa	1·040	12·782	Pine (St. Petersburg)	0·490	13·300
Cork	0·240	12·782	Plum	0·490	11·351
Cypress	0·644	12·782	Plum	0·490	12·782
Cypress	0·644	6·895	Pear	0·661	12·782
Damson	0·780	14·000	Pomegranate	1·354	11·501
Deal (Norway)	0·340	18·100	Pomegranate	1·354	8·308
Deal (English)	0·470	7·000	Poplar	0·360	7·200
Deal (Scotch)	0·498	4·290	Poplar	0·383	6·641
Deal (Scotch) yellow	0·472	8·478	Poplar (Spanish)	0·529	6·641
Elder	0·695	10·230	Poplar	0·529	4·596
Elm	0·671	13·489	Quince	0·529	5·878
Fir (American)	0·416	8·874	Quince	0·705	8·822
Fir (Riga)	0·416	9·072	Sallow	0·700	18·600
Fir (Russian)	0·459	10·008	Sycamore	0·690	13·000
Filbert	0·600	10·008	Sassafras	0·482	13·000
Hawthorn	0·910	10·700	Tamarisk	0·482	6·895
Hawthorn	0·910	9·200	Tamarisk	0·482	11·247
Holly	0·760	16·000	Teak, old	0·530	8·200
Hazel	0·600	16·000	Teak (Java)	0·697	14·220
Jujube	0·600	18·915	Teak (Malabar)	0·688	13·140
Jasmine	0·600	12·020	Teak (Segu)	0·619	13·194
Jasmine (Spanish)	0·770	12·020	Vine	1·327	13·194
Juniper	0·556	12·020	Walnut	0·590	7·800
Laburnum	0·920	10·500	Walnut	0·671	7·800
Lancewood	1·010	23·400	Willow	0·390	14·000
Lancewood	1·022	24·696	Willow, dry	0·390	7·628
Larch	0·636	11·093	Yew	0·790	8·000
Larch (Scotch)	0·496	7·888	Yew (Dutch)	0·788	8·000
Lemon	0·703	9·457			

NOTE IX.

THE LARGEST BELT IN THE WORLD.

STEADILY and surely the use of wheel gearing for main driving is becoming obselete, being displaced by the rival systems of belt or rope driving, which systems again, are in rivalry with each other. We need not enter into the question of the relative merits or demerits of main driving with ropes or belts. Suffice it to say, both methods have their adherents, and there does not seem much probability that either of them will oust the other from the field. Our present article will be confined to belts for main driving made of leather, although, as our readers know, some very large belts have of recent years been woven from cotton or made from folds of canvas stitched together.

When all the power of a mill engine has to be transmitted by a single belt, the belt, of necessity, has to be very wide, and consequently heavy, and, so far, unmanageable. It is, therefore, generally preferred to have several belts, side by side on the fly-wheel rim, but each belt driving its own section of the mill. Instead of taking off the power with one belt and splitting it up afterwards, it is at once distributed at the engine. But under some circumstances—

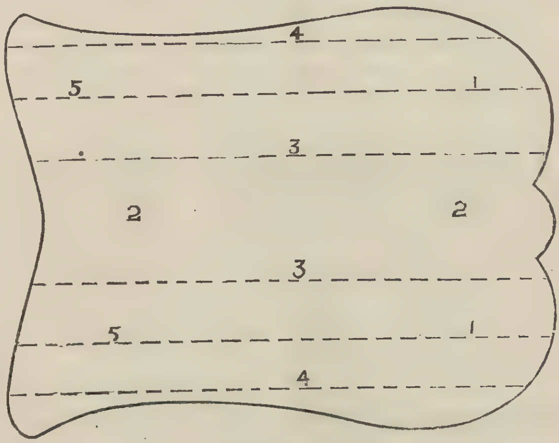


FIG. 1.

in driving weaving sheds especially—this plan is not practicable, and the power has to be transmitted from the engine by a single belt, and thus it is that the monster belts we hear of are becoming so common.

To make what we now understand by large belts—those, for instance, over three feet wide—in leather is a more difficult task than is commonly supposed, as it demands much skill and judgment to obtain thoroughly satisfactory results. The principal cause of the difficulty lies in the want of uniformity in the leather. If we take a butt—that is, the largest piece of leather that is obtained from the hide—and which is, in short, the raw material of the strapping manufacturer—we find it varies greatly, both in thickness and texture. In Fig. 1, which is a sketch of a butt, the parts 1 1, which covered the buttocks of the animal, and the parts 2 2, up the middle, or those which covered the back, contain the thickest and firmest leather. At 3 3, the material is practically of the same quality, but as we pass to 4 4, or the belly

part, it becomes thinner and of a softer and more spongy nature. The leather at the shoulders 5 5 also, is of much lower quality. Therefore, in making a large strap, unless much discrimination is used in cutting up the butt so as to obtain the strips of leather of uniform texture and thickness, the strap, when it comes to be strained and stretched in working, will yield unequally, and as

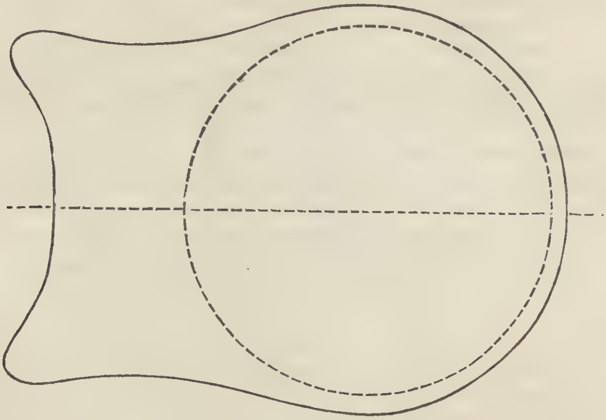


FIG. 2.

a consequence will run crooked and altogether work unsatisfactorily. The ordinary way of cutting the butts is shown by the dotted lines in Fig. 1. The middle and widest strip is even throughout, and is the only piece that is faultless. The others contain leather of variable quality, with the best at one end and the inferior at the other, which, needless to say, is most undesirable.

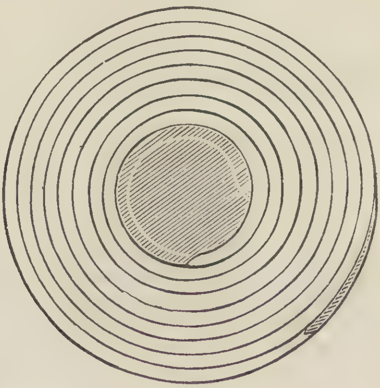


FIG. 3.

Mainly with the object of avoiding this drawback, Messrs. Sampson and Co., strapping manufacturers, of Stroud, patented, some years ago, what many will consider a curious system of making belts. Their method, although at the time of its introduction a striking departure from the ordinary practice of the trade, is a very simple one, and, after thorough trial, seems to have established

itself and proved its value. A great number of large belts, to which it appears to be peculiarly well adapted, have at different times been made by Messrs. Sampson and Co., and we have no doubt many of our readers will be interested in a description of the system as we saw it carried out in a recent visit to Stroud. The leather used by the firm is English oak-tanned, supplied from tanneries in the neighbourhood. The butt is placed on the floor, and with it a large pair of compasses the workman strikes out the largest circle possible that will exclude the inferior leather. Referring to Fig. 2, it will be noticed that the belly and shoulder parts are outside the circle, which therefore includes only the best portion of the butt, and leather that is practically equal in strength and thickness. The circles are cut out of the butts and are used for making belting, a large butt giving a circle about 4ft. 6in. to 5ft. diameter, the remainder of the butt being sold to shoemakers. After being curried and dressed in the usual way, the circles are cut into very long strips of leather by taking the cut in a spiral, as shown in Fig. 3, the centre part, about 18in. diameter, being discarded. These strips are made of different widths, as circumstances require, and generally

FIG. 4.

come out from 100ft. to 140ft. long, being of course shorter when the strip is wider. At it is comparatively seldom that belts exceed this length, the ordinary but objectionable cross joints become unnecessary, and a prolific scource of weakness and failure is obviated. The strips so obtained are now separately stretched on a long bench, one end being fixed and the other drawn out by a kind of small windlass. Whilst in its stretched condition the leather is well "rubbed down," and, as it were, consolidated. The treatment of separate strips in this way is considered one of the good features of the system, because it enables the "stretch" to be taken very effectively out of the leather, giving as a result a belt that, although new, will remain tight and work much longer than usual without taking up. With large belts this is a very important point. The strips, after stretching, are placed side by side, and sewn together in sufficient number to give a belt of the desired width. The edges of the strips are channeled, as represented in Fig. 4. The sewing is done by hand, and, of course, with waxed thread, the object of the workman being to pull the strips firmly together, edge to edge, with the stitches lying in the bottom of the grooves. After sewing,

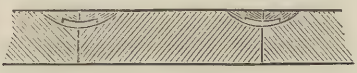


FIG. 5.

these latter are closed up and hammered level. Up to this point there has been obtained what appears to be a piece of leather of single thickness, of the width and length of the intended belt. All large belts are made double or have two thicknesses of leather. Two such pieces, therefore, as we have just described, are cemented together, face to face, with a layer of canvas between. They are further secured by driving in small wooden pegs about half an inch apart, and arranged in rows along the strips. Pegging the two halves of the belt together in this manner has been found more preferable than sewing with a machine. The pegs are made very dry before being driven, and when the moisture in the leather causes them to expand they become all the more secure in their holes. They also add to the durability of the belt, for the same reason as pegging a boot sole enables it the better to resist the wear. Messrs. Sampson and Co. had just completed—to the order of a Belgian firm—what, in all probability, is the largest belt ever made, and at the time of our visit it was being rolled up previous to delivery. The width is 75in. and the length is 153ft. 6in. The

weight is estimated at about 25cwt., and it is intended to transmit about 600 I.H.P., the driving drum being 28ft. in diameter and the driven 8ft. 6in. The strips used for making the belt are about $2\frac{1}{8}$in. to $2\frac{1}{4}$in. wide, there being 32 on one side and 33 on the other. The purpose of the odd one is of course to break the joints.

Altogether this belt must be considered an excellent and substantial piece of workmanship, that speaks well for the resources at command of its makers; and no doubt others besides ourselves will feel a little patriotic self-complacency when we add that it is to replace one of foreign manufacture that, in a few months after being started, failed in working.—*Textile Manufacturer.*

NOTE X.

A MODEL MILL IN GERMANY.

It has often been remarked by travellers on the Continent that the outward appearance of cotton and other textile mills is better than that of many similar establishments in England, the reason for which is generally not far to seek, as most of these mills are of modern erection, and have consequently had the advantage of the experience of our own millowners and architects. Besides, a new building always looks fresher in a bright than in a damp and smoky atmosphere. That we now have handsome mills of every kind in this country no one will deny who takes the trouble to look for them. But while travellers report about the outside appearance they generally know nothing about the inside. From what we have seen on the Continent we can affirm that generally the inside cleanliness corresponds with the appearance of the outside; but very often the superiority over similar mills with us ceases after pronouncing the word cleanliness. Order, regularity, quietness, and promptitude cannot be found abroad as in our best establishments at home. There are, of course, exceptions, but we are speaking of the average. Under these circumstances it is gratifying to come across some model mills, of which there are here and there a few. We will select one near the Rhine, to show our readers what can be accomplished by an intelligent millowner who has the well-being of his hands at heart.

The mill in question contains 12,000 throstle and 370 doubling spindles, and employs 200 hands, of whom two-thirds are females, but only five or six are married women, and 30 children. The time made during the week is $65\frac{1}{2}$ hours, including cleaning time on Saturdays, the hours being from 6-0 in Summer and 6-30 in Winter to 6-45 in Summer and 7-45 in Winter, the dinner hour being from 11-50 to 1-15. On Saturdays the machinery is stopped at three o'clock, and the cleaning done until four; in Winter this is done half an hour later. Young people have half an hour's rest in the morning, so that they only work 60 hours.

The mill is built fireproof throughout; the floors are laid with flags and tiles; all doors and windows are of wrought iron; the pillars are cast iron; all roofs are fireproof and carry water cisterns, with the exception of the engine roof; and all stairs are of stone and contained in separate fireproof wells.

The heating is done throughout by wrought-iron steam pipes; in each room there is a thermometer with a plainly visible scale, and it is the duty of the overlooker to see that the thermometer does not rise above 68° or 70° nor fall below 65°; the watchman has likewise to see that at the commencement of the work in the morning the temperature stands at 65°.

The lighting is done by gas, and all burners are provided with regulators, so that no unconsumed gas can escape into the rooms.

Each window has on its upper portion a part of about one square yard area, which swivels, and can be opened or shut from below so as to ensure thorough

ventilation without draught. There is also ventilation through the iron pillars, and ventilating shafts are inserted in the walls.

On the top landing of the stairs there is a cistern in which in the morning and the afternoon water is boiled by steam, and which is carried by pipes into all the rooms, where the latter are provided with from two to four taps, so that the hands can draw hot water for making coffee. All rooms also contain water-pipes and plugs, and provision for washing hands.

There is a dining room for those hands who live too far away to go home to dinner, and here the young people have also their half hour's rest.

There is a reading room at the service of all employed in the mill, out of working hours, free of charge, and a library, for the use of which a trifling charge is made. The books which are least read are history, natural history, politics, and biographies; the boys read as much again as the girls, and both together one-third more than men and women together.

A novel feature is a fireproof bathing house, containing two rooms, in which hot, cold, and shower baths are arranged, and hot pipes for warming towels and the clothes. All hands may use these baths during the time between 8-0 a.m. and 7-0 at night, and must give notice beforehand to the foreman of their intention, who then assigns to each his time, allowing about half an hour for a bath, and arranging the allotment in such a way that at one time only men and at another time of the day only women may bathe. All bathing is done during working hours (!) Each person has to pay one penny for a bath, for which also soap and towels are furnished. These baths are patronised principally in summer only, as many as 20 persons using them in a day; but at any time the women resort to them only sparingly.

There is a savings' bank and sick fund connected with the mill, both being managed by the firm. The contributions to the sick fund, which is compulsory, was last year $1\frac{7}{10}$ per cent. of the wages, to which the firm added 50 per cent. In the course of years this fund has accumulated money for which the firm pays 5 per cent. interest, and in order to prevent its getting unnecessarily large, the contributions have this year been lowered to $1\frac{1}{2}$ per cent of the wages.

The contributions to the savings' bank are not very numerous, though the firm allows 5 per cent. interest, the members being at the end of last year only nine, with a capital of £260. There is, however, an insurance office in the town with an endowed fund for insuring payment in advanced age (commencing with 55 years), to which the hands of the mill contribute more liberally, while the firm have privately set aside a certain amount for aged hands of the female sex.—*Textile Manufacturer*.

NOTE XI.

LOWCOCK'S IMPROVED FUEL ECONOMISER.

When the apparatus now known universally as the Fuel Economiser was first introduced, many years ago, by the late Mr. Green, of Wakefield, it was up to that time one of the most important improvements that had been made in the economical generation of steam—that is, the economical use of fuel—and hence the name by which it is so happily described. Of the advantages attending its use there was no room for dispute. The apparatus was most extensively adopted, and at the present time it is exceptional to find new boilers laid down unless in conjunction with an economiser. It is therefore satisfactory to know that the inventor reaped a very rich reward.

It is scarcely necessary to say that the object of a fuel economiser is to abstract the heat from the hot gases that leave the boiler flues, which heat, unless so abstracted, would be wasted up the chimney. The primitive idea of an economiser was to lay the feed-water pipe on its way to the boiler in the flue

leading to the chimney. This heated the feed, and was thus an advantage, but it acquired only a little of the heat in the escaping gases, the surface exposed by the pipe being so small. The result is obtained by multiplying the number of pipes through which the feed-water has to pass. A difficulty was found in the fact that the soot deposited on the pipes acted as a non-conductor, and greatly impaired their efficiency. Scrapers were therefore applied, which being kept constantly moving along the pipes kept them clean, and thus gave econo-

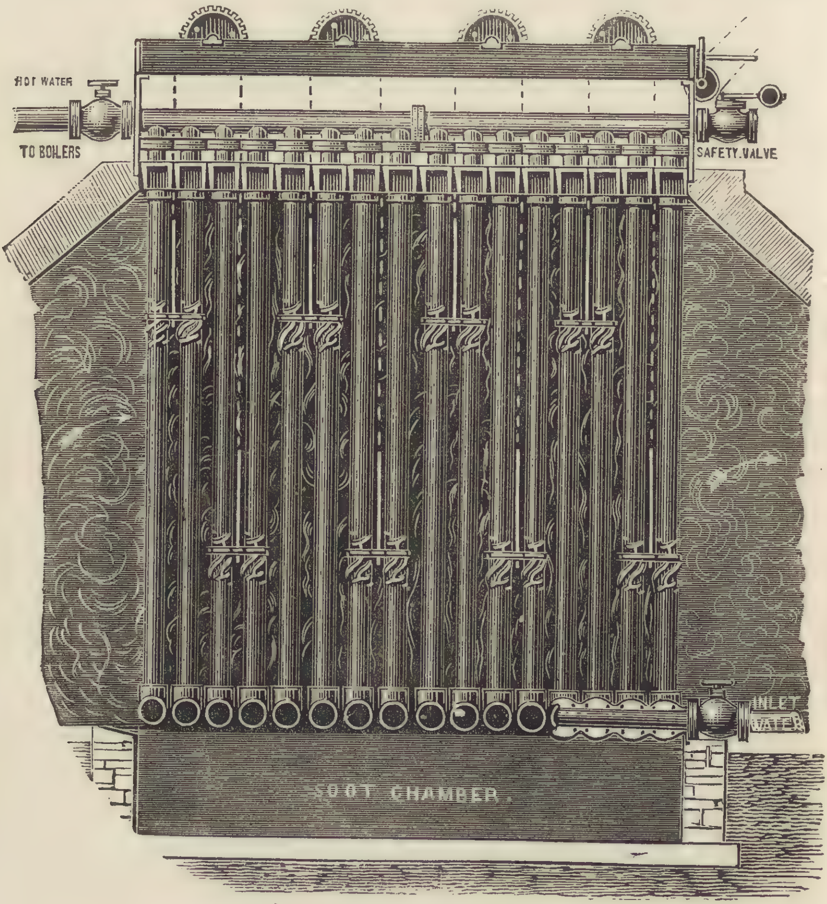


FIG. 1.

miser pipes the full benefit of the heat in the flue. As so arranged, a high temperature may be attained in the feed-water. An average of 260° is by no means an uncommon occurrence, and very often it is even higher than this; but it depends upon circumstances, chiefly the draft and position of the economiser.

The full utility of the economiser is not always appreciated. It is frequently looked upon as a mere feed-water heater. It is undoubtedly this which yields the benefits of heating the feed, these being chiefly lengthening the life of the boiler and lessening the deposition of scale in its interior. When the water is

bad it is sometimes objected that the pipes will choke up. This, however, is an advantage, because the deposit that forms in them is much more easily removed by boring it out than by laboriously scaling off the plates. But the economiser is also a powerful auxiliary to the boilers. It may be taken that an apparatus of average size is equal to one boiler in four. With the economiser three boilers will do the work of four, thus saving the labour and fuel required by the fourth.

Judging by the total absence of any successful innovation of economiser making, it would seem that in its general features the arrangement developed by Mr. Green cannot be departed from with advantage. Others in the business therefore follow substantially the same lines, the various apparatus differing only in details—that is, in the gear for working the scrapers, the scrapers themselves, and the mode of jointing the pipes.

Fig. 2.

The illustrations given herewith relate to the economiser made by Mr. Arthur Lowcock, engineer, of Shrewsbury, whose works we recently visited for the purpose of seeing the mode of manufacture adopted by him. It is an important point in connection with the economiser that the pipes should be well cast, that they should be of uniform thickness all round, free from blow-holes, and that, outside particularly, they should be as smooth as it is possible to make them, for obviously, it is easier to keep a smooth pipe clean by scrapers than a rough one, lessening also the probability of the scrapers sticking. To this point Mr. Lowcock gives particular attention, and he claims to be the first in this business who adopted the system of casting the pipes vertically, and in dry sand moulds. This plan has undeniable advantages over the ordinary method of casting on the bank. The core is kept truly central because the metal has no tendency to float the middle out of position, and the casting being done under a large head of

metal perfect soundness and absence of blowholes are insured. The pipes come out perfectly round, of uniform thickness, and with extremely smooth surfaces. That the scrapers in an economiser should act efficiently is of paramount importance, and sometimes they have to act under trying conditions. Dry soot is easy enough to deal with—may be blown off, in fact—but when it is of a tarry nature and sticks to the pipe it then has a tendency to be rubbed down and plastered into a thick coat that is troublesome to remove. Lowcock's patent scrapers, shown enlarged on Fig. 2, are designed to obviate the possibility of them shirking their work, any tarry or sticky matter tending to make these scrapers cling on to the pipes. The top and bottom of each scraper cling to opposite sides of the pipe, being connected spirally. A group of three surrounds the pipe, overlapping one another, and, as may be seen, leaves no part uncovered in its travel. At this part an addition is made in the shape of a bar, which, as the scrapers descend, and when near the bottom, passes between the bottom boxes into the soot chamber beneath. This is intended to keep the spaces between the bottom boxes always clear, and prevents any soot lodging there and afterwards banking up in the economiser.

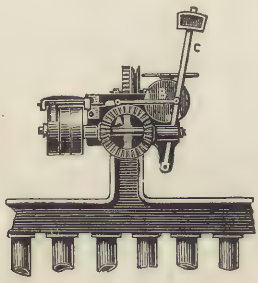


FIG. 3.

The mode of stacking the pipes together deserves mention. They are forced into taper sockets in the bottom boxes, as is the usual way. At the top, however, they have turned collars that fit a short distance into parallel-bored sockets in the top boxes. The remainder of the joint is caulked up with iron-borings cement, making a reliable rust joint, and insuring every pipe as tight and secure as its neighbour. This plan offers certain facilities for readily removing bursted or defective pipes and replacing them. The lids on the top boxes, which in some cases have to be removed frequently to clear the interior of the pipes, are made with flat faces, which joint is preferred by the maker as being easily detached and not liable to get fast.

The reversing motion for the scrapers is shown in Fig. 3. The wheel A is on the worm shaft, and the disc B, which revolves slowly, carries two cams, which move the lever and weight C over the centre, and shift the strap from the pulley that drives one of the bevel wheels to that which drives the other, thus making the reversal. This motion appears to be simple and reliable. A little improvement has also been made in the fact that the worms work immersed in oil cups with bearings to take the end push of each of them. As we have said, there is no room for striking and novel departures in the construction of fuel economisers, but it seems clear that the maker of the apparatus we have described has carefully studied the various conditions of the working of economisers, and has endeavoured to meet them.—*Textile Manufacturer.*

NOTE XII

THE AVOIDANCE OF TALL CHIMNEYS.

LIVET'S PATENT SYSTEM OF SETTING BOILERS.

THE invention that we will endeavour to describe in this article is one that is well worthy the attention of our readers, whether they be steam-users or not. Its extreme novelty, the radical departure it embodies from existing practice, and the fact that it has yielded beneficial results when, from the mode employed, ordinary experience would say such results could not be expected, makes this system of boiler setting worthy of careful study by users of steam power. We say frankly we were incredulous as to the claims made when this system was first brought before our notice, and we also acknowledge we cannot give any reason, scientific or practical, to account for the results that are undoubtedly obtained. Some of our readers might be able to do so. What we will now say must be mainly descriptive.

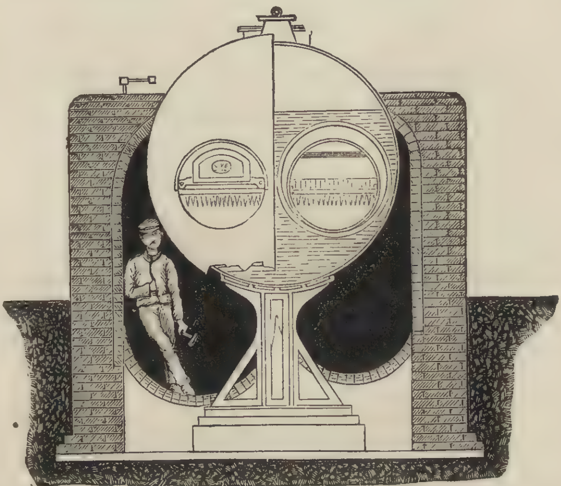


FIG. 1.

We write for practical men, and if at this point a reader refers to some of the illustrations, and says, "Oh, mid-feather wall—bad practice—no good," it is only fair to the system we have under notice that he should reserve his opinion awhile.

It seems reasonable to think that with the experience hitherto gained in the setting of the hundreds of thousands of boilers now in use (even in Great Britain only) with the ample directions and vigorous inspections of the boiler insurance companies respecting them, there is not much room for novelty or improvement in this direction. This will naturally cause any striking innovation to be received with a great deal of scepticism and even prejudice. The latter in technical matters should never be present.

We confine ourselves to land boilers of the Lancashire or Cornish type, as being the most employed in manufacturing, although Livet's system has its application to other descriptions. Usually the brickwork setting of these boilers provides for two side flues and one bottom flue, the latter splitting into the former. The mid-feather system of setting is discredited, and we only allude to

it to say so. As compared with Mr. Livet's proportions the flues in the old system are much contracted, and in this lies the principal difference. Ordinarily four square feet of flue area is reckoned enough for a boiler. Some do with less. The fire bridge in the old plan is narrow, and it is not considered good practice to have it too near the crown. In Livet's arrangement the bridge is made widė, tolerably near the top of the tube. The flues are arranged on the plan of the "wheel draught"—that is, the hot gases pass through the boiler tubes to the back, and then through a side flue to the front, and then through the other side flue to the damper, as shown in plan (Fig. 3), the side flues being divided by a wall up the middle of the boiler, as illustrated in section in Fig. 2. The boiler is supported upon cast-iron saddles (Fig. 1), and not upon the mid-wall, which it barely touches, the top layer of bricks being bull-nosed, and the bricks under the rivet seams being left loose to facilitate inspection. Thus the boiler is not by any means supported by a mid-feather wall.

We come now to the cardinal feature of the new system. With the ordinary mode of setting the boiler cannot be worked up to its full steaming capacity

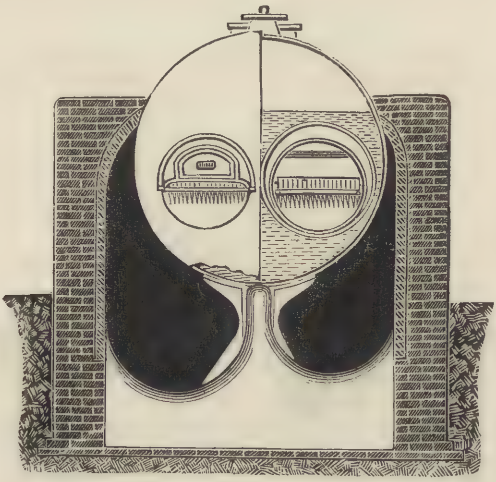


FIG. 2.

without the fire being urged by artificial draught. The commonest way of obtaining this draught is by a high chimney. By the Livet arrangement the latter may be dispensed with, as it is not relied upon to the smallest extent to produce draught, it being only necessary to provide a chimney shaft about 60ft. high to carry the spent gases above the level of the surrounding buildings. The draught is obtained by allowing free expansion of the heated gases themselves in their course through the boiler flues. The area of the flues is made in comparison with the common practice, very large, and it increases step by step as it approaches the chimney. It will be seen in Fig. 2 that the first side flue—the right-hand one—is larger than the second, the left-hand one.

These large flues expanding in area induce in some way, probably by reduction of friction, an extremly strong draught, a draught sufficient to burn such refractory fuel as anthracite, coke, breeze, etc. It is also insisted in favour of this method of setting boilers that the fuel is consumed in the most economical manner practicable, and that the system gives better results as regards smoke prevention and evaporation with all kinds of fuel than those yielded under equal circumstances by the common method. The absence of priming and a greater

dryness of the steam are also features that are claimed in its favour. No priming and dry steam are for many reasons most desirable. Another point, however, deserves mention. With these flues it appears to be unnecessary to bank up the boiler fires at night. If the damper is closed, although the fire is purposely allowed to burn out, and has to be lighted in the morning, there will still be nearly the full boiler pressure, 5lb. less or thereabouts. The boiler we examined, set on the new principle, was worked in this way—the fires lit with waste paper every morning half an hour before starting the engine. The size of the flues offers unusual facilities for inspection and cleaning when required, a point of considerable importance, and one that will be appreciated by the boiler insurance companies.

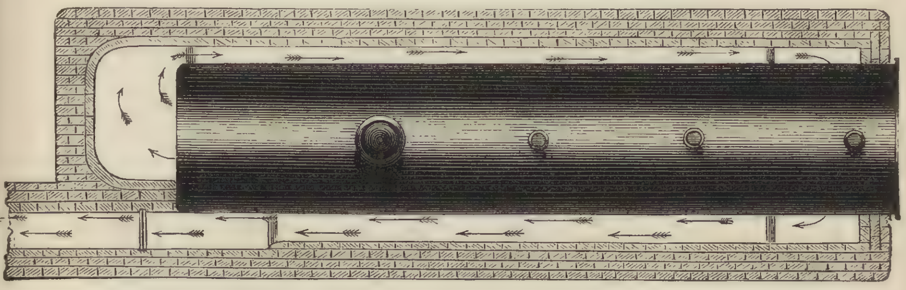


FIG. 3.

The grate bar used in connection is considered by Mr. Livet to be an integral portion of his system of working boilers. It is a duplex bar, one being under the other. The upper bar has a general resemblance to the common form; the lower bar is for the purpose of making it deeper, in preference to making it 1ft. deep in a single casting which would be fatal to its durability. A two-fold result appears to follow from this construction, *i.e.*, the heat is conducted away and the bars kept cool where in contact with the fire, thereby increasing their durability, the heat conducted away at the same time heating the air issuing into the fire. These bars have proved more than ordinarily durable under the hottest burning fuels, like anthracite.

The patents relating to the combined inventions, embracing others of which we have to postpone notice, are being worked by Messrs. Livet and Company, Limited, 2, Short Street, Finsbury, London, E.C. The boiler we examined (at the printing works of Messrs. Clay, Sons, and Taylor) was the one tested and reported upon by Mr. D. K. Clark, upon which report the company received the highest award in this class from the late smoke exhibition. This boiler was also used for the valuable tests of the heating power of different fuels made by the same well-known engineer, who said: "In Livet's system of setting boilers it is not at first sight obvious that, by the employment of expanding flues of a special shape and construction, a materially better action of the furnace and boiler should be effected. It has, nevertheless, been ascertained by many instances of re-setting on Mr. Livet's system that the draught has been improved and the evaporative efficiency augmented. By referring to the results of the tests it will be seen that, in the boiler at the works of Messrs. Clay, Sons, and Taylor, which is set and fitted on Mr. Livet's principle, very high evaporative efficiencies of fuel have been attained. The large capacity of the flues, it may be added, affords exceptional facilities for inspection of the boiler."

These economical results are confirmed by Messrs. Tate and Sons, sugar refiners, Silvertown, who say that, "according to their experience, the evaporative efficiency of their boilers, burning 6cwt. of coal per hour per boiler, has been increased from 6·39lb. of water, supplied at 66° F. per pound of coal, to 7·40lb., by the substitution of Livet's system of setting boilers."

The system has now met with a large adoption amongst large boiler-users in the south of England. It is also being applied in the manufacturing districts, and we have no doubt many of our readers will be interested in the progress made. It is scarcely necessary to say that the new mode of setting does not occupy more space than the old style, and that the re-setting can be accomplished without detaching the pipe joints.—*Textile Manufacturer.*

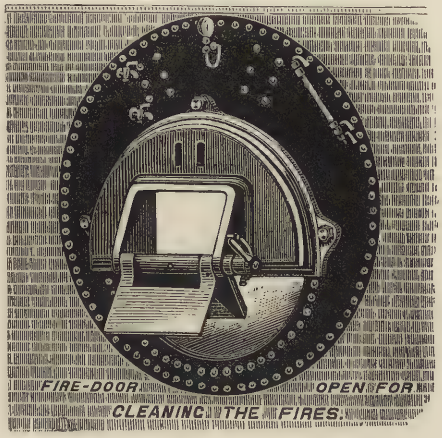
NOTE XIII.

Mr. Henderson, of Liverpool, makes two exhibits, one of his patent furnace front and fire door, the other of his well-known mechanical stoker. The furnace door is considered one of the best appliances for its purpose shown in the exhibition. We have seen it applied to many boilers in different places, and its utility is highly spoken of, it being easy to handle without the usual discomfort. The furnace front is double, so constructed that a current of air passes between. The air becoming heated, escapes either above or below the dead-plate, according to the fuel used. The furnace door has a piece of the dead-plate solid with it, the combination forming a V-shaped casting. This swings between projecting cheeks cast on the furnace front. The door and dead-plate are

FIRE-DOOR CLOSED.

balanced, so that they will remain in any position. The manner of using this door is best explained by the illustrations here given. For the purpose of firing, the door is pushed inwards, the dead-plate falls downwards, the door taking its place. When sufficient fuel has been supplied, the door is returned to its normal position by giving it a quarter turn upwards. When the furnace has to be raked out, the door is turned completely over at right angles to its normal position. This leaves the doorway open, and also the space usually closed by the dead-plate. Through this latter the clinkers fall into the ashpit. During the process of raking out, the door and the dead-plate hanging below the doorway form a screen, which not only protects the stoker from falling live clinkers, etc., but also forms a heat screen, which prevents radiation from these

heating the boiler-room. The fumes and gaseous matter arising from the hot clinkers, together with the heated air, pass upwards through the space which the dead-plate closes when the door is shut. Thus the deleterious fumes ascend direct into the flue over the fire without having an opportunity of diffusing themselves and contaminating the air of the stokehole. Fuel may be shovelled into the furnace whilst the door and dead-plate are hanging downwards, so that the stoker is thus spared the annoyance of sulphurous fumes in the stokehole. We described Mr. Henderson's stoker in our issue for August, 1877. It is of the type in which the fuel is first crushed, and then projected on to the fire. This is done by a pair of horizontal fans revolving at high speed. The grate consists of movable bars worked from the stoker by a rocking crank and eccentric arrangement, one half the bars moving up and down whilst the other half move to and fro horizontally, the combined movement being intended to break the clinker. The clinker, instead of being raked out of the furnace in the usual way, by hand, is carried automatically to the back of the grate-bars, and remains there till cool, when it is removed without the furnace doors requiring to be opened. Hand firing, in case of necessity, may be resorted to.



The next on the list is the improved form of Proctor's stoker he has lately patented. We gave a detailed description of this in our issue for August, 1881, so a mere allusion to it here will be sufficient. This stoker, like the two preceding, belongs to the class in which the crushed fuel is thrown, not pushed, on to the fire. It imitates the shovelling operations probably more closely than any of the appliances exhibited, and it is much to be commended for its extreme simplicity. The coal is fed from a hopper by a horizontal ram, which passes it into two boxes, each immediately above the fire doors. Each box contains a vibrating shovel, worked by a spring. The shovels, having three distinct throws, spread the fuel evenly over the fires. A feature claimed, is the arrangement of the ram and its box, which dispenses with the necessity of having a hopper to each fire. It will also allow large coal to pass down without interfering with the feed, which is regulated by a ram, working on the bottom of ram-box, that pushes the coal alternately to each fire, thereby insuring a positive feed. Hand firing may be practised with the same ease and with the ordinary fire door. This machine took one of the two second-class prizes at the London Exhibition, and there is no doubt that, worked in conjunction with a good movable bar, it forms a most effective firing arrangement We note that Mr.

Proctor has commenced the manufacture of these machines on his own account at the Hammerton Works, Burnley, and hopes thereby to be able to guarantee the quality of workmanship they contain.

The next on our list is the patent mechanical stoker and smokeless furnace made by Messrs. T. and T. Vicars, Steel Street, Liverpool. This machine is distinguished by its substantial construction and the shortness of its bars. We described it fully in the *Textile Manufacturer* for September, 1877, but since then it has been improved in several details and the construction cheapened. It is of the ram and movable-bar type, of which it may be considered the father. In this class the idea is to push the fuel into the front of the fire by rams working forward, the coal thereby becoming gradually coked as it is forced onwards, and it is only natural to expect that this mode of firing should be practically smokeless. We thus find that Messrs. Vicars' machine took one of the two first prizes at the previous exhibition. The movable bars have a curious motion. They move forward altogether and backwards in sections. The clinkers fall behind the fire into the flue, from whence they are easily removed without disturbing the fire. The rate of burning may be varied within very wide limits by altering the travel of the bars and the stroke of the plungers. For facility of regulation in this respect it seems to us the machine cannot be improved.

NOTE XIV.

FOR many years past the diameter of the standard Lancashire boiler has been 7ft., but with the recent advance in steam pressures, and the equally rapid advance in the manufacture of steel of reliable quality and of a durability suitable for boiler plates, together with the latest improvements in the details of construction, a larger diameter is now very frequent, and we have therefore illustrated the 7ft. 6in. boiler in preference to that of 7ft., as being the now customary usage, though boilers of 8ft. diameter are by no means uncommon. As the scale of our illustration is $\frac{3}{8}$in. to the foot, the dimensions may be readily scaled off. We need only remark that they represent the most approved modern practice in both the boiler dimensions and in the arrangement of the fittings and setting.

The following, however, are the chief dimensions and strengths, the strengths given being equal to 100lb. working pressure :—

	Ft.	In.
Shell { Length	30	0
Shell { Diameter inside small rings	7	6
Thickness	0	$0\frac{1}{2}$
Flues—Diameter	3	0
,, —Thickness	0	$\frac{7}{16}$
Number of flanged seams, 9		
Length of firegrate	6	0
Grate area	36	sq. ft.
Number of Galloway pipes each flue, 5		
Thickness of end plates—Front	0	$\frac{9}{16}$
,, ,, —Back		
Water space between furnaces	0	5
,, ,, tubes and shell	0	$4\frac{1}{2}$
Diameter of safety valves, each	0	4
,, manhole	1	4
,, mudhole, 15in. by 12in		
,, rivet holes on shell	0	$\frac{13}{16}$
Lap of plates, single riveting	0	$2\frac{1}{4}$
,, double riveting	0	$3\frac{7}{8}$

The end plates of the boiler are of steel, and secured by angle irons to the shell, also of steel, 3in. × 3in. × $\frac{9}{16}$in. These angle irons are usually $\frac{1}{16}$in. thicker than the plates of the shell, and are of steel also. The end plates also are usually

SEVEN FEET SIX INCHES LANCASHIRE BOILER.

CONSTRUCTED BY MESSRS. W. AND J. YATES, ENGINEERS, CANAL FOUNDRY, BLACKBURN.

From "MECHANICAL WORLD," Sept. 11th, 1884.

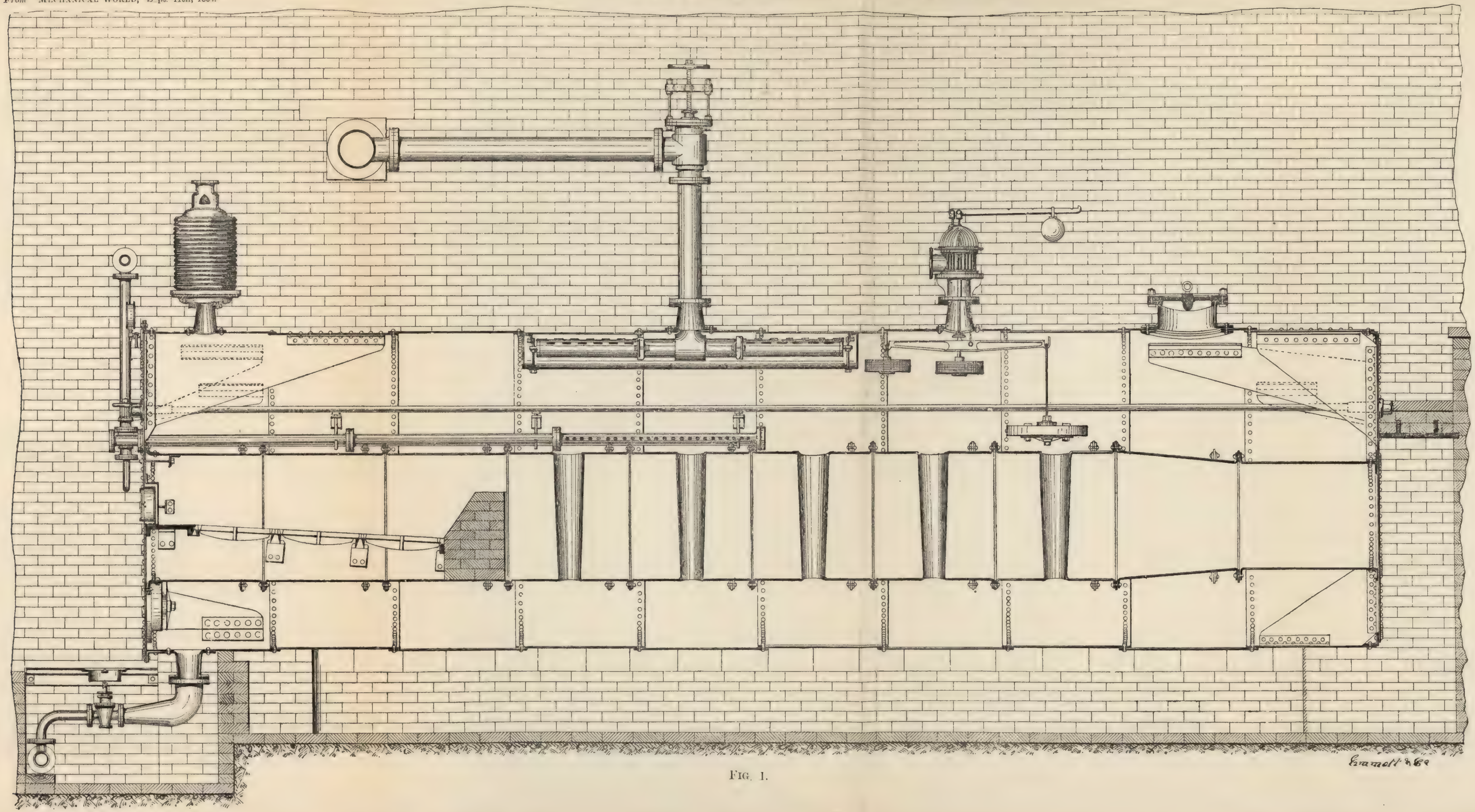


FIG. 1.

Back of
Foldout
Not Imaged

about $\frac{1}{16}$in. stronger than the shell plates. In addition to the angle iron attachment the end plates are further stayed to the shell by gusset plates, which, as plainly shown, are secured by double angle irons, 3in × 3in. × $\frac{7}{16}$in., to the ends and shell. The distance between the bottom rivets of these gusset angle irons in the end plates and the ring of rivets securing the flue tubes to the end plates is nowhere less than 10 inches, this being required to give elasticity to the end plate so as to prevent grooving around these angle irons, or straining and possible fracture at the roots of the angle irons. For years it was the practice to make the above distance only small. The writer has seen many old boilers in which it has not exceeded 3in. Then, as experience taught the necessity of an increase of this which is usually termed the breathing space, it was increased to 7in., then to 8in., and so recently as 1881 it stood at 9in. Now 10in., and even 10½in., is no uncommon allowance. The internal circular flues are of themselves, if plain, insufficiently strong to resist the pressure of the steam, which tends to flatten or collapse them. On this account they are built up of several segments, which are united by means of the Adamson flanged seam. This joint has the great advantage of being strong, elastic, and in having no rivets exposed to the fire. By its adoption the flues may be made of any required strength. It has been proved experimentally that the adoption of the flanged seam at every 3ft. on a 2ft. 9in. tube enables it when of ⅜in. plate to resist over 300lb. pressure per square inch without showing signs of distress. No really good and reliable formulæ have been discovered which serve to determine the strength of tubes to resist collapse, but the data derived from experiment are sufficient to determine the proportions in practice.

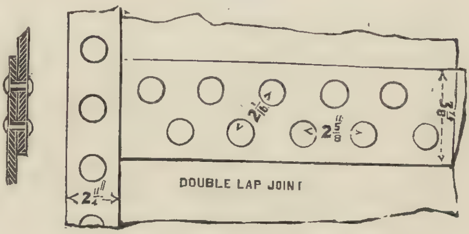


FIG. 3.

The manhole mouthpiece is of wrought iron, double riveted to the shell of the boiler, and the edge of the hole cut out in the plate is further strengthened by means of a strip of wrought iron about 5in. × ½in. through which the rivets of the mouthpiece pass. The smaller fitting blocks are also of wrought iron, as is also the block on the front end of the boiler bottom for the attachment of the blow-out apparatus. This is a most important fitting. The elbow pipe which is attached to the blow-out block should be large and strong, and the cock should be of the double gland description, as shown, with a waste pipe to the drain, or to some safe point well away from the boilers.

It is the opinion of some engineers that the blow-out elbow pipe should be of wrought iron, and we are disposed, after seeing several near escapes from scalding due to failure of these pipes, to agree with this.

It is almost needless to say that at Messrs. Yates' works all the holes are drilled in position, thus securing the strongest possible joint. Indeed, for good boilermaking the use of the punch is quite out of the question, and is now considered a barbarism.

Seeing that the strength of a boiler is that of the weakest part only, it is important that no part should be unduly weak. Until quite recently the manhole, when fitted, as was the custom, with a cast iron mouthpiece, was the weakest link of the chain. We have seen, however, that this weak point has been strengthened by the use of a wrought iron manhole, and of an additional

strip ring also, internally applied. The weak point now is the longitudinal riveting, and it is therefore important that this should be as strong as possible. The practice of drilling in position in place of punching was a big step in the right direction, but it is equally important that the pitch and diameter of the rivets should also be suitable. In Messrs. Yates' practice, which is practically that of all first-class makers, the holes in plates of the thickness of this boiler, namely, $\frac{1}{2}$in., are drilled $\frac{13}{16}$in. diameter, the sharp edge being afterwards taken off the edges of the holes.

The rivets used are $\frac{1}{16}$in. less, but of course when closed they will fit the holes tightly. The ring seams are single riveted, the pitch being 2in. The longitudinal seams are double riveted, the pitch being $2\frac{5}{8}$in. on the straight and $2\frac{1}{16}$in. diagonal. Our readers may calculate for themselves the proportion of plate to rivet section, not forgetting that it is the diameter of the drilled hole which must be calculated, not the diameter of the rivets used, for these fill the hole when closed up. For pressures of 100lb., however, the double-riveted double butt joint is employed, of dimensions herewith shown. Each butt strip is $\frac{5}{32}$in. thinner than the plates of the shell.

The Galloway pipes, of which there are five in each tube, are welded into their place. The rings of the flue are also welded so as to ensure a more perfect circularity than is obtained by the use of a riveted joint. After welding up the rings are placed upon a block and the flange formed by means of wooden mallets, by

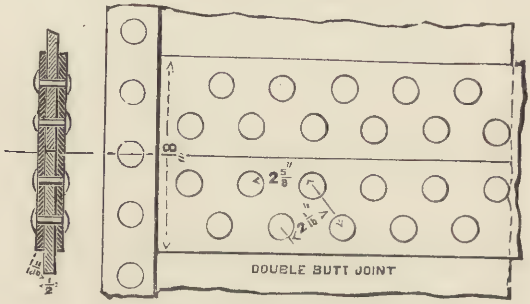


FIG. 4.

which the flanges are bent over on to the edge of the block, suitably rounded for the purpose. Some makers do this flanging by machinery. Messrs. Yates prefer the handwork as being less severe upon the plates. It will be observed that the internal flues are reduced in diameter at the back end; this is done for two purposes. In the first place, it allows of a man getting down between the tubes into or out of the bottom of the boiler. This alone is an important desideratum. Another reason is that the back end plate may be attached to the shell by inside angle irons, as it is evident that an outside joint, as at the front end, would be unsuitable, being exposed to the great heat of the flues. The reduction of the internal tubes makes this inside joint practicable.

It will be noticed that two longitudinal stay bolts pass between the end plates. These stays relieve to some extent the strain upon the gussets, but it is important that they be not too taut, or they may cause the end plates to groove seriously around the flue angle irons. Properly speaking, there should be one longitudinal bolt only, but this being inapplicable owing to the middle gussets, two are used, which should be as close to each other as it is possible to design, and when screwed up they should have a swing laterally of five inches or so to prevent the above-mentioned grooving. Though so slack they will serve as supports to the end plates and relieve the transverse seams of a portion of their strain. Some engineers, however, insist that the longitudinal stay bolts is not in any way a necessity. For our own part, however, we are disposed to accept

them as a useful precautionary addition. We would remark, however, that the washers beneath the nuts at the ends should not exceed about 4in. diameter and ½in. thick, and a nut and washer should be placed on each side of the plates, as shown, and tightly screwed up, the inner nut being nipped up as soon as the bolts are drawn up to the requisite tightness by the outside nuts.

There are several smaller points of considerable importance about a boiler, one of which is that the bearers which carry the firebars must not be allowed to rest upon the sides of the furnaces. They must rest upon supports riveted to the plates. This prevents the bearers cutting into the plates.

Another point of importance is that the brass fittings of the glass water gauges should be strong and massive. This is rarely the case in practice, and in

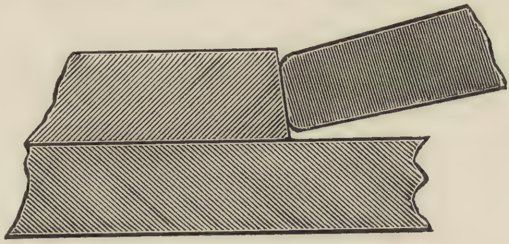


FIG. 5.

too many cases these glass gauge cocks are merely shells. Messrs. Yates, who make their own taps of best gunmetal, cannot be blamed in this sense, for their taps are of the right sort, and not such as to break off on the slightest touch or stiffness. A good tap, moreover, is not constantly leaking over the boiler front, disfiguring the boiler-house and defeating every effort of the fireman to be tidy.

However well put together a boiler may be it is impossible that it should be watertight with simply riveting up. To ensure tightness the edges of the plates are caulked or fullered. Some makers caulk both inside and outside the boiler, others outside only, believing that inside caulking has a tendency to causing corrosive channelling of the plates adjoining the caulked edge.

Fullering is to be preferred to caulking. In the latter operation a narrow tool is used which drives a narrow strip of the plate forcibly upon the plate

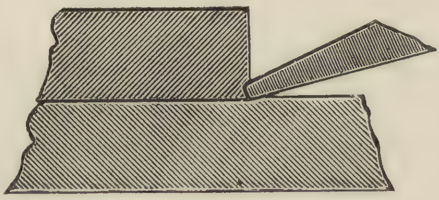


FIG. 6.

below. In fullering a tool is used as broad upon the face as the plate is thick. The whole edge of the plate is thus thickened up and the seam closed tight. Fullering has thus a less injurious effect than caulking, and is to be preferred.

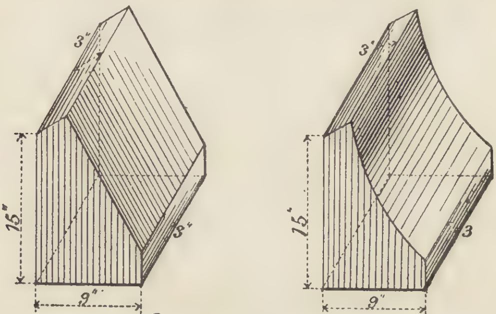
The annexed sketches show the difference between the two methods.

With a boiler of this size two safety-valves are usually provided. One should be of the dead-weight type, such as the Cowburn, Brierley, Hopkinson, Eaves or Jordan ; the other may be of the ordinary lever type, and one of the two valves should have the low water arrangement of the Hopkinson or Kay description. Where box valves are used they should not have stuffing-boxes. The spindle of the valve should pass freely and loosely through the cover. Waste

pipes should be provided with drain-pipes to remove all condensed water. If the boiler is covered with composition or brickwork the manhole and other fittings should be kept clear of this covering, which should be stopped off clear of the flanged attachments, and finished neatly by a ring of iron or by bull-nosed bricks. The covering should be kept whitewashed and clean. A white covering causes far less loss by radiation of heat than does a covering of a darker colour. The other fittings usually attached are 2 pairs of glass water-gauges, feed pipe, scum cock, and pressure-gauge. A pointer is fixed to show the average working level of the water, which should never be less than about five inches deep over the furnace crowns. When the depth is reduced to five inches the low water safety-valve ought to commence to blow off.

Internally are fitted a scum trough to the opening of the scum cock and a perforated feed distribution pipe for the purpose of gradually dispersing the feed water instead of letting it in in a body in one place and so causing local cooling and consequent damage to the boiler.

We ought not to omit mention of the anti-priming pipe which, about 6ft. long by 6in. diameter and perforated, is fixed below the steam junction valve, as shown in our drawing. The object of this pipe is to act as a collector of steam without water. It serves the purpose of the old-fashioned dome in securing dry steam, which, being drawn from a considerable length of the boiler, at a



Seating Blocks

FIG. 7.

large number of small slots in the upper part of the pipe, is less liable to carry along with it particles of water, such as are drawn up when the steam opening is left unprotected.

The foregoing are all the fittings really necessary. Many others are often applied, such as alarm whistles, fusible plugs of doubtful utility, etc. A very useful, and if once properly set a very good adjunct is a self-acting damper, by means of which the pressure is regulated to a fixed point, the damper opening and closing according to the pressure. Such a boiler as we have described with a fair draught ought to consume hourly per square foot of grate surface about 20lb. of coal. This is a convenient rate of consumption which, though often exceeded, is perhaps as much as ought to be calculated upon without a forced draught. With good coal each pound consumed will evaporate from 8lb. to 10lb. of water, supplied at 212° temperature, according to the cleanly state of the boiler and the efficiency of the fireman.

The proper setting of a steam boiler is of recent date. It is particularly to be observed that the front end of the boiler should stand at least 4½ inches clear of the brickwork of the front cross wall so as to leave open to view the joint of the angle iron attachment. Further, the bottom edge of the front end plate must be well clear of the floor-plates over the hearth pits. These floor-plates, which rest at one end on a girder which passes along the front of the cross wall below the boiler and at the other on the opposite edge of the hearth pit, should be

narrow. They are thus, being of little weight, easily removed for the inspection of the hearth pits, the blow-out taps, etc. In order that the blow-out pipe may not be in danger of fracture from any accidental settlement of the boiler it should be quite free from contact with the brickwork, which is built in the form of a chamber large enough to expose fully to view the blow-out block and its joint to the boiler shell. The girder carrying the floor plates has a web projecting above the floor to prevent ashes falling into the pit.

In seating the Lancashire boiler it must rest upon two longitudinal walls, capped with blocks of fireclay, similar to those shown in annexed illustration. The edges upon which the boiler rests is from $2\frac{1}{2}$in. to 3in. wide only, so that a full inspection may be made. The use of these blocks also enables the floor of the side flues to be kept well below the line of seating. This not only facilitates inspection, but in case of possible leakage or other accidental inroad of water keeps the plates dry.

Where the ring seams of the shell cross the seating walls these latter should be cut away fully 5in. in length by about $2\frac{1}{2}$in. in depth, so as to allow of the ring seams being inspected for possible leakage and corrosion. The parts thus cut out should be filled by specially made wedge pieces of firebrick, so as to admit of instant removal and insertion by the inspector. As a rule, these channels or pockets are either never cut at all or they are filled by lumps of soft fireclay or broken brick. All this is untidiness, and should be abolished, as wedge pieces of suitable form are easily made, and should be supplied to the number of at least a score with the seating blocks of each boiler. The course

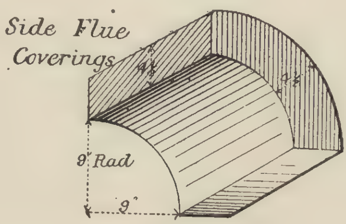


FIG. 8.

of the products of combustion after passing out of the internal tubes is, firstly, beneath the bottom of the boiler in the bottom flue, which should not be less than two feet deep at the middle. At the front end the draught splits, half passing along each side flue. The narrowest part of the side flues should be at least 9in. wide at the level of the full horizontal diameter of the boiler, and the crowns of these flues are covered in by curved blocks of fireclay, such as we here illustrate.

Some prefer that the course of the draught shall be from the tubes, down the side flues, and away to the chimney by the bottom flue, but this plan does not secure uniformity of heat throughout the boiler. By the first method the boiler bottom is better heated and circulation promoted, seam rents being rendered less likely than is the case when a mass of cold water remains undisturbed along the shell bottom, as is often the case when the bottom flue is the coldest of the three. At the back end of the boiler, at the downtake from the iron flues to the bottom flue, there should be at least a space of two feet between the back end of the boiler and the back wall of the downtake, and a step, consisting of a projecting brick or piece of cast iron, should be fixed into the brickwork at such a height as to facilitate the climb from the bottom flue into the tubes. Unless this is provided there is often a difficulty in getting about the boiler, which should never be the case, for it cannot be too well remembered that in hot flues or other difficult situations work should be made as easy and tolerable as it reasonably can be. The downtake flue also is

covered in by curved blocks of fireclay, as shown in Fig. 9, though, as shown in longitudinal section, this roof may also be made with bearers of cast iron supporting brickwork.

We might add finally that where practicable the side flues should join in one flue before entering the main flue to the chimney instead of each passing directly into the main flue. This greatly facilitates both the work of the sweep and of the inspector.

There should be a damper to each side flue when direct, but when the two merge into one a single damper alone is required in the combined flue.

Dampers should always be hung by a chain over easily running pulleys and suitably counterbalanced and arranged in such a manner as to be adjustable by the fireman at the front end of the boiler without leaving the firehole.

To those who would place their boiler-houses in a really creditable state we might add that the brickwork of the front wall and the side walls of the boiler-house are best when faced with white enamelled bricks. They are bright and cheerful and easily cleaned, and more than repay their cost by the increased care and attention wihch every good fireman will give to a boiler-house when not, as

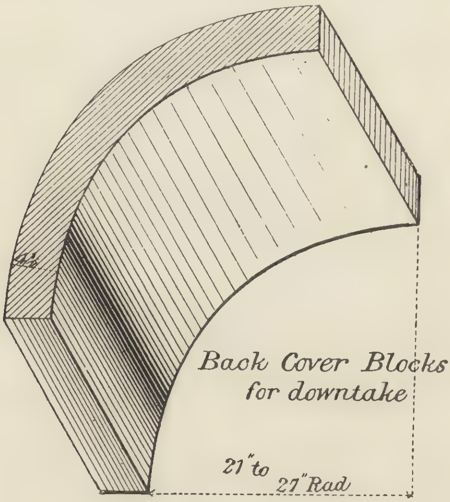


FIG. 9.

too many are, wholly beyond the capacity of any man to keep in order. It is perhaps needless to say that a boiler should not be placed in a damp situation. If this cannot be avoided, a bed of good cement concrete 6in. thick should underlie the whole of the brickwork, and if dampness is to be feared through the walls as well as from the floor this concrete bed should be continued upwards also to the level of the ground outside, thus securing a damp-proof tank in which to build.

Dampness about the seating of a steam boiler is most dangerous. It is responsible for the majority of the most disastrous explosions.

All Messrs. Yates' boiler fittings being made by themselves on their own premises, and special care being devoted thereto both as regards finish and testing, adds greatly to the success of the boilers. Notwithstanding the numerous modern deviations from the "Lancashire" type of boiler and the advantages claimed therefrom, the verdict of steam users is yet, and appears likely to be, most emphatically in favour of the county name and description. Nothing has yet been designed that under continuous use and experience affords the

same uniformly good results and satisfaction. One reason of this is that the water surface is great, and steam is thus set free in a dry condition, priming never occurring to the excessive extent which is the case with boilers having a small water surface and a great depth.

In our illustrations Fig 1 is a longitudinal section through the boiler, showing also a section of one, the tube and a full elevational view of the blow-out arrangements, safety valves, steam and anti-priming pipes, feed pipes and staying. The remaining figures of the riveting plan and seating blocks need no further explanation.

We need only add that all feed pipes, steam and blow-out or scum pipes should have elastic connections, and be nowhere bound fast or tight where passing through floor plates or walls. It may be laid down as a good rule that all holes for the passage of pipes, should exceed the diameter of the pipes by $\frac{1}{2}$in. plus one-eighth of the pipe's diameter.—*Mechanical World.*

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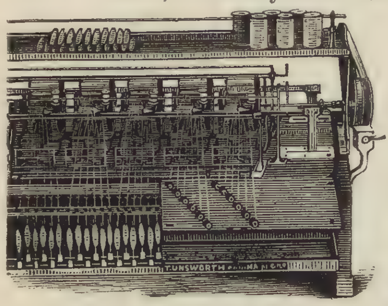

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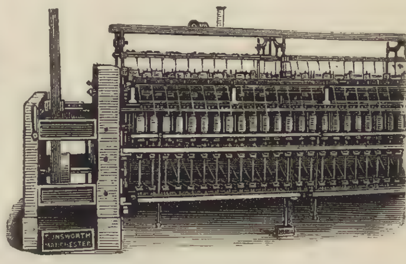

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